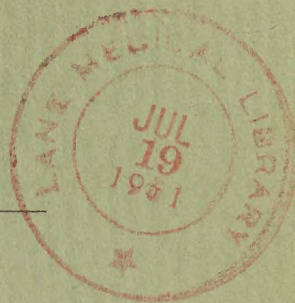


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# CARDIAC INFARCTS

TREATED IN THE DEPARTMENT OF MEDICINE OF THE  
UMEÅ CENTRAL HOSPITAL 1939—1950 WITH VIEWPOINTS  
ON THE PROBLEMS OF CARDIAC INFARCT

By

SVEN EKVALL

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UMEÅ 1955





*SVEN EKVALL*

**CARDIAC INFARCTS**



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FROM THE DEPARTMENT OF MEDICINE, UMEÅ CENTRAL HOSPITAL  
(HEAD: S. EKVALL, M. D.)

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TREATED IN THE DEPARTMENT OF MEDICINE OF THE  
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*SVEN EKVALL*

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UMEÅ 1955

Preliminary communication read at the  
meeting of The Swedish Association for  
Internal Medicine at Umeå 10.3.1951.

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# INTRODUCTION

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*The present work is based on the cases of acute cardiac infarct admitted to the Department of Medicine of the Umeå Central Hospital during the period 1939—1950. It was evident that these cases increased in number, particularly during the last few years. Similar observations have been reported elsewhere by other workers. The same question has arisen here as in other places as to the cause of this increase, whether due to an increased morbidity among the population or due to other contributory factors. At the same time it was noticed that the number of infarct cases at Umeå Hospital was low in comparison with the figures published by other Swedish Hospitals. The reason for these conditions as well as for other problems related to cardiac infarct I shall discuss on the basis of observation on my own material. Particular attention will be paid to the genesis of cardiac infarct and problems connected with it with a view to elucidate the frequency of cardiac infarct.*

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*The electrocardiographic examinations have been conducted by Dr. Gunnar Jungner in the Clinical Laboratory at Umeå Hospital and the pathologico-anatomical investigations by Dr. Carl-Wilhelm Lundquist. These two colleagues of mine have also provided me with much valuable information in discussing the cases.*

*The statistical work has been carried out at the State Institute of Racial Biology, Upsala, under the leadership of the Director of the Institute Professor Gunnar Dahlberg who has also given me valuable help in discussing the problems.*

*Professor Erik Ask-Upmark, Upsala, has shown a keen interest in the problems dealt with.*

*Valuable help has been given by Mr. Pontus Viklund of the Umeå Country Council in collecting the demographic data. Mr. Nils Tärnvik, secretary of the Rural-Economy Association, has kindly provided particulars on the food stuff situation in the county.*

*Miss Dagmar Mark has been of great help to me in typing the manuscript and in drawing up the Tables.*

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S. EKVALL

# PART I

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## *The Problem of Cardiac Infarct* *General outline*

Cardiac infarction has during the past decades received keen attention by all branches of medical science. Though the disease was known earlier, and then of particular interest to pathologists, it was during the earlier part of this century that clinicians began to pay special attention to this condition. This was connected with the progress of electrocardiography which increased the possibilities for a more definite diagnosis *intra vitam* and widened our knowledge and understanding of this disease. In this case as in so many other diseased conditions, when the diagnostic possibilities increased, it became evident that we were dealing with a disease which was far more prevalent than was previously considered.

The increased number of reported cases in many countries also suggested that the frequency of cardiac infarcts mounted. The hectic speed of life was thought to be one of the causes of »blood clot in the heart» and it appeared that special professions were particularly prone to be in danger. Names such as »Wall Street-disease» and »The Doctor's disease» are evidence hereof. The general public was upset by the apparent uncertainty of the nature of the condition. The unsuspected and violent manifestation, as well as the often fatal result, caused fright. An intensive research concerning the various problems related to cardiac infarcts was undertaken and particularly in the U. S. A. much literature has been published as a result hereof, mainly since the latter years of the decade 1921—1930. Eckerström (1951) has given in his thesis an excellent résumé of the development of our knowledge to which he has added his own observations on the clinical feature and prognosis of cardiac infarct.



# Chapter 1

## *a. The Pathogenesis of Cardiac Infarct*

In spite of the increased knowledge which research work has led to there is still no complete understanding regarding the innermost cause and mode of origin of the cardiac infarct. As a knowledge of the pathogenesis of the cardiac infarct is fundamental for what is to be discussed in this paper, I wish first to mention some of the circumstances which are of essential importance for appreciation of this problem and its solution.

The disturbance of the myocardial nutrition, which is the cause of the cardiac infarct, occurs when there is a discrepancy between the nutritional requirement and the ability of satisfying such requirement. In simple language this lack can be explained by the constriction or occlusion of the coronary vessels whereby the nutritional supply is diminished or stopped. The most common cause of this is arteriosclerosis of the coronary vessels. One had earlier observed the close connection between coronary sclerosis and cardiac infarcts. Further pathologico-anatomical investigations verified this. Bean (1937) found coronary sclerosis in 92.2 % on a post-mortem material which included 300 cases of cardiac infarcts.

Experience has, however, taught us that a high degree of ob-  
turing coronary sclerosis does not necessarily lead to an infarct. It may be noted that a certain degree of nutrition of the myocardium can be obtained through extra-coronary vessels and direct from the lumen of the heart. An important nutritive function can also be kept up by coronary anastomoses between the coronary arteries themselves as well as between these and the extra-coronary arteries and, further, by the arterio-luminal and the arterio-sinusoidal vessels. The effect of such anastomoses can be traced by the fact that an infarct, as a rule, is smaller than the area of supply of the obturated blood vessel. The size of an infarct is dependent not only on the size of the area of supply of the affected artery, or branch of the artery, but also on the collateral nutrition of the neighbouring vessels.

Though the infarcts are most commonly found in the wall of the

left ventricle, and these infarcts are as a rule the most extensive and produce the gravest symptoms, they are not uncommon in other parts of the heart according to Söderström (1948), who has made a special study of the infarcts in the auricles where the infarcts, as a rule, are small and often remain un-noticed. The anatomical conditions and the mechanism for the blood supply seem to create more favourable conditions for nutrition of the thin-walled auricles and the right ventricle and contribute to the infarcts there never becoming so extensive; further, that an infarct in the wall of the left ventricle often does not extend over into the right ventricle in spite of the fact that these parts of the heart may have an area of common arterial supply. First and foremost, the greater functional strain, typical of the left ventricle, seems to create a greater demand for a thorough blood supply and hence this part of the heart becomes more vulnerable owing to deficient nutrition (Büchner 1939).

Our knowledge of the anastomoses and their function is of importance in order to understand the patho-physiology of the coronary arteries. By means of the anastomoses it is to a certain extent possible to make an exchange between the different systems of vessels. The coronary arteries and their branches should, therefore, not be considered endarteries in a strict sense, which had long been considered the case, based on ligation of vessels in experimental animals carried out by Cohnheim and von Schultess-Rechberg (1881). Spalteholz (1924) deals with this in his work on the arteries of the cardiac wall and gives an abstract of the many examinations and discussions which concern these problems. From this work may be noted that Lower, a London-physician (1631—1691), as a first observer mentions the inter-coronary anastomoses and proved that if fluid was injected into one coronary artery, branches of other arteries were also filled, and that Haller, a Swizz (1708—1777), clearly dissected out the anastomoses; that attempts to improve the technique for demonstrating the anastomoses finally led to injection of contrast fluid and roentgenphotography (Baumgarten 1899), and finally to the technique with »Durchsichtigmachen» and contrast fluid which Spalteholz (1914) worked out by means of which complete understanding was obtained. The findings gained by Spalteholz have been essentially confirmed by

Gross (1921). We know now that an extensive network with larger and finer anastomoses exists between the larger coronary arteries as well as between their branches. Particularly rich is this network of anastomoses in the subendocardial layer of the left ventricle.

Spalteholz emphasises the importance of senile changes in the development of the collateral circulation. He mentions that a gradually progressive arterial obturation results in an increasing dilatation of the anastomoses by means of which a condition for sufficient blood-supply is created. If there is a sudden closure of an artery the anastomoses do not get sufficient time to dilate and the result is an infarct. The coronary vessels should, according to Spalteholz, be considered as »bedingte Endarterien».

Schlesinger (1938) points out that as a result of this experiment by injecting variously coloured fluids, the coronary arteries in healthy persons, even in old people, are endarteries in the sense that Cohnheim maintains, but that anastomoses develop when arteriosclerotic stricture and occlusion make it necessary. Blumgart et al. (1940) have further investigated this by using a lead-agar suspension which does not pass through the thinnest vessels and capillaries while the thinner solutions do. By means of the more viscous suspension they have been able to decide where the inter-coronary arterial communication takes place. These authors found in normal hearts no inter-coronary anastomoses of a greater diameter than  $40\ \mu$ . These vessels are far too narrow to ensure satisfactory nutrition in case of acute coronary occlusion. By obstructing the blood flow anastomoses with a diameter from  $40$  to  $200\ \mu$ . developed regularly. An infarct does not necessarily form and life can be maintained in spite of complete occlusion of two or even all the three coronary main branches if the occlusion takes place gradually and anastomoses of sufficient capacity for nutrition have developed. Zoll. et al. (1951) have later proved by injecting a roentgen-opaque lead-agar suspension of definite viscosity followed by roentgen examination and dissection that the intercoronary anastomoses are present in less than 10 % in persons with normal hearts. They develop also in more persons and in an increasing degree in order to compensate relative blood insufficiency of various origin, not only caused by arteriosclerotic stricture but also in cases of anaemia, cor pulmonale,

valvular disease and cardiac hypertrophy. The anastomoses increase with increased stricture formation, and they have been shown to give protection against organic injury of the muscle even when complete arterial occlusion is present. In cases of old occlusions the anastomoses were found in 100 % while in recent occlusions they were present in 74 %. When occlusion has taken place practically all hearts show the presence of anastomoses (Schillingford 1952).

The relative lack of oxygen supply to the myocardium with an increase of certain metabolic products or an accumulation of such in connection with the disturbed blood flow has been considered as a stimulus for developing anastomoses. A mechanical factor asserts itself in particular through a difference in blood pressure with a lower pressure distally to an arterial closure.

It may be mentioned that an increased demand for blood supply to the myocardium can be met in a different manner also. According to several authors it has been shown that in cases of cardiac hypertrophy there is an increase in size of the larger coronary vessels. Schillingford (1952) has observed proliferation of even the smaller vessels when the myocardial hypertrophy has formed more slowly such as in valvular disease or benign hypertonia with enlargement of the left ventricle.

Thus we should have to count with the appearance of a cardiac infarct in case of sudden arterial occlusion e. g. in haemorrhage in the intima, atheromatous substance entering the lumen or embolus, in such a way that satisfactory anastomotic circulation is not given enough time to form. As early as 1935 A. Jervell wrote that the development of anastomoses explains that the rapidity taken by an occlusion to form determines the formation of an infarct and also its extent, further, that the occlusion most frequently produces the most serious symptoms in those who have not previously had any evidence of coronary disease and that, all things being equal, the infarct becomes larger in a younger than in an older person.

A cardiac infarct can, however, form even without a sudden occlusion. It is thus evident that a cardiac infarct may form in case of insignificant arteriosclerotic changes and without demonstrable



occlusion (Gross and Sternberg 1939), or even with normal or slightly altered coronary vessels (Lisa and Ring 1932).

If it is not a question of coronary obstruction of the normal blood flow the circulation may be greatly impeded mechanically in cases of valvular disease of the aorta, cardiac weakness or a fall in the blood pressure. But the nutrition of the heart may also deteriorate through anaemic conditions and pulmonary causes (*cor pulmonale*) when the quantity of blood may be sufficient but the quality unsatisfactory. There may also be the question of an increased nutritional need of the heart itself which, for various reasons, is difficult to safeguard against despite the fact that the influx of perfectly good blood may be normal or even above-normal. Under this heading belong conditions resulting in enlargement of the heart. The enlarged heart is in need of increased nutrition for its myocardium. This nutritional difficulty seems not to be fully explained. Above has been mentioned the favourable possibilities present for supplying blood to the hypertrophic heart. According to Gross and Sternberg (1939) the nutritional difficulties should depend on the fact that the enlarged muscle fibres in cardiac hypertrophy receive a relatively poorer blood supply because the number of capillaries do not increase. Gross and Spark (1937) have observed a reversed relation between the thickness of the muscle fibres and the number of capillaries. The greater demand for nutrition of the enlarged heart should consequently lead to a relatively low capacity.

An increased function of the heart puts greater demand on the nutrition of the heart and from this follows the risk that this cannot be satisfactorily effectuated, especially in conditions as mentioned above. This increased heart function is found in physical and psychic strain, hypertonia, valvular disease, extensive pulmonary resistance, anaemia, tachycardia and infections. To this ought to be added obesity which causes an extra demand on the heart's function.

From what has been mentioned, it ought to be clear that a cardiac infarct does not owe its origin to anatomical changes in the coronary vessel system only; functional discrepancies in the coronary circulation also play their part. Having chiefly paid attention before to the pathologico-anatomical changes in the heart one now arrived

at the conclusion that certain disturbances in the function of the heart were caused by an alteration in the coronary circulation. The connection between angina pectoris and coronary sclerosis had been observed. Crainicianu (1922) who considered that angina pectoris was evidence of a disturbed balance between the heart function and its blood supply, pointed out that this symptom, under certain conditions, could be found in individuals with normal coronary arteries. Since pathologico-anatomical causes were not adequate he looked for an explanation by means of a physiologico-experimental method of circulation.

It was Rein (1931) who fully elucidated the physiological rules for coronary circulation and coined the term *coronary insufficiency*. According to Rein coronary circulation adjusts itself to the functional need of the heart. This circulation may become insufficient when decreased without the function of the heart diminishing to a corresponding degree, or when the heart function increases without coronary circulation increasing accordingly.

The patient experiences this acute coronary insufficiency as angina pectoris. Through the work of Büchner (1939) we know that morphological changes in the heart may develop in the form of more or less numerous myocardial necroses, localized particularly to the inner layers of the left ventricular wall and in the papillary muscles and trabeculae of this ventricle. On healing these necrotic foci leave fibrotic cicatrices. Dietrich and Schwiegk (1933) pointed out that angina pectoris was caused by hypoxaemia which also produced changes in the electrocardiogram with a lowering of the S-T segment. Such hypoxaemia caused by coronary insufficiency was recorded by Büchner and von Lucadou (1934) electrocardiographically on experimental animals before the appearance of necroses. Angina pectoris should thus be fundamentally caused by a disturbance of the metabolism in the heart muscle owing to acute hypoxaemia.

Based on this supposition, one may reason that if the myocardial ischaemia is slight and of short duration there may follow only a passing attack of angina pectoris. If it is of a more severe degree depending on the insufficient blood flow in relation to the need, and if lasting over a longer period, the risk of producing the more serious

malaciae increases which, as already mentioned, will be principally localized to the left ventricular wall. Dietrich and Schwiegl (1933) pointed out also the transitional border between the electrocardiographic changes in angina pectoris and cardiac infarct. It is of interest to note that Söderström (1948) agrees to the conformity in size between some of the disseminated auricular infarcts, studied by him, and Büchner's myocardial necroses.

Determining the formation of an infarct is therefore not the type of circulatory disturbance but the degree to which the acute demand on myocardial nutrition may be effectuated. Blumgart et al. (1940) have shown that considerable changes in the coronary vessels, including stricture and blockage, may appear without any symptoms which they explain as being possible owing to a satisfactory collateral circulation. If this does not take place there is an increased tendency for angina pectoris and myo-malacia; similarly, if the myocardium is in need of a greater supply of blood, as in hypertrophy or for other reasons, the same known conditions stimulate the development of anastomoses. The general condition of the heart is, as a matter of course, of importance because the diminished coronary blood flow in the insufficient heart creates a favourable tendency for myocardial ischaemia to develop.

In this connection may be added the risk of an acute coronary insufficiency becoming a cardiac insufficiency with fatal issue. This may happen even if the clinical symptoms of an infarct have not developed. Sudden fall in blood pressure and collapse, tachycardia and fibrillation may be signs of warning. The size and localisation of the ischaemia decide the formation. With an extensive myocardial fibrosis present the severity increases on account of the impeded heart function. In addition cardiac hypertrophy may have a deleterious influence. Ischaemia, for some reason, more readily causes myocardial damage in the presence of cardiac hypertrophy when there is a diminished nutritional reserve. This seems to explain the sudden deaths in affections with pronounced cardiac hypertrophy.

Much has thus been said as to the cause of myocardial ischaemia. In addition to this cardiac infarcts might also be produced by a spasm of the coronary arteries. That this may be the case in certain

abdominal diseases is pointed out by Andersson (1950) who refers to his own observations and to the literature. An active function of the vagus might give an explanation of this and of the fact that cardiac infarcts very often appear during night time and during sleep. It might be proved that the vagus carries constrictor fibres to the coronary vessels, but it has been difficult to show definitely such vascular contraction induced by nervous impulses. In any case it has not been proved conclusively that what we clinically term cardiac infarct has been caused by an angiospasm in the coronary system of nervous origin. Dietrich and Schwiebk (1933) considered that they could exclude coronary spasm as a cause of angina pectoris pain being provoked by anoxia. After reviewing different conditions considered to be related to this Pickering (1951) emphasizes that the view regarding serious and localized arterial spasm, developed without any accepted stimulus, has been described too freely and without due criticism.

Further confusion in the discussion has been added by the opinion that adrenalin dilates the coronary arteries but constricts the peripheral ones. Maybe the investigation made by Hirsch (1952) resulted in a change of thought on this question. He was able to prove by experiments on dogs, and by using a special fixation method, contraction of the fine coronary arteries after injecting 0.200—0.250 mgm adrenalin. In this connection I wish to mention the investigation which Söderbergh (1926) made, followed by pharmacological and physiological tests, that as far as the heart is concerned no complete antagonism between the ortho- and parasympathetic function could be said to exist. The observed dilating effect of adrenalin and nor-adrenalin may, according to Folkow (1953), be considered as wholly, or to a great extent, secondary to the metabolism in the stimulated cardiac muscle cells. It may be noted that Rein (1931) according to his own observations came to the conclusion that the vaso-constrictor tonus of the vagus fibres is not overcome by physiological doses of adrenalin but that adrenalin thereby produces its effect on the heart muscle.

Against the importance of coronary vascular spasm it has been argued that the vessels concerned are very often far too rigid in order to react with appreciable constriction. The fall in blood pressure



during sleep is more likely to be influential. Blumgart et al. (1941) further point out that the inability of these vessels to dilate during exertion may be a factor to count with in explaining the myocardial ischaemia. The conditions for producing coronary insufficiency do not seem to necessarily presuppose that it is a question of vaso-constriction. On the other hand may be mentioned the vasodilating effect of metabolic substances in cases of myocardial activity and the relative ischaemia together with the cardiac vessels' adaptability for dilatation in view of the circulatory reserve present. The good effect of the nitrites in cases of angina pectoris may be found, not so much in the obturated vessel, as in the vessels and their collaterals through the widening of which the ischaemic area can obtain a satisfactory blood supply. Most likely a certain fall in the blood pressure may also favourable influence the metabolism within the ischaemic area (Folkow 1953).

It may be fair to suppose that even if other causes are present or play their part, it is chiefly in the arteriosclerosis of the coronary vessels that we have to look for the primary source of the cardiac infarct. Hence it is evident that if a clarification of the various problems associated with the cardiac infarct is to be gained the origin and development of the arteriosclerosis must be elucidated. The progressive investigation of arteriosclerosis and the knowledge gained hereby concerning the cardio-vascular diseases has thus placed the disease of cardiac infarct in its medical and social relation. It is evident that, except where there is an acute occlusion, there are functional factors which play a decisive role in causing a serious nutritional upset in the myocardium and resulting in a necrosis. Investigation of the problems of cardiac infarct has thus led to a close connection in investigating the factors deciding the function of the heart. Not only purely medical questions have thus aroused interest but also social ones which are discussed below.

### *b. The Frequency of Cardiac Infarct*

Concerning the social questions of importance in connection with the cardiac infarct problem it has become urgent to obtain an eva-

luation of frequency for this disease among the population. But it has proved difficult to attain reliable results. A certain understanding of the mortality and its fluctuating figures has been obtained through the close connection between arteriosclerosis and cardio-vascular diseases as judged by the statistical figures on material from the autopsies in hospital practice. The changeable clinical picture of the cardiac infarct makes it very difficult to obtain a reliable estimation of the morbidity of this disease among the population. With the clinical diagnosis becoming more definite these difficulties have decreased in degree. On the other hand it must be admitted that this has resulted in an increased number of diagnosed cases without any real increase taking place. In the same way must be considered the estimation of frequency of cardiac infarct among the population based on the increased number of patients suffering from this disease admitted to hospitals.

Among the many authors investigating coronary diseases, I wish to mention in particular the Americans Master et al. because they have dealt with this subject through a series of questions like those used in this investigation. They maintain (1939) that heart diseases are the foremost cause of death in the U. S. A., but that even if they have observed a marked increase in the number of cases of coronary disease and cardiac infarct during the past decade in the U. S. A., this increase may be explained as being due to a lowered mortality in case of infectious diseases thanks to improved therapy, a raising of the average age of the population and an increased number of old people; further, in the improved diagnostics and a stricter terminology in the statistical work. In 1942 it was estimated that coronary disease and angina pectoris made up 8.5 % of all deaths in the U. S. A. Master (1947) is of the opinion that coronary disease is the most common of all the heart diseases and that coronary occlusion in the official statistics of deaths is given as myocardial disease in 25 %, as coronary disease in 60 % and as angina pectoris in 80 %. Based on his investigations Master (1947) maintains that conclusive proof has not been shown that the increase in coronary disease should have any connection with the strain and stress of modern life, and he denies that certain professions and mode of living

as well as the food question, tobacco or alcohol would influence the frequency of these diseases among the population.

Even in our country during the past decades the cardiovascular diseases have been subjected to an intensified study, owing to improved diagnostic means and because of the importance these diseases have created. Henschen (1950) compared the cause of death for the period 1928—1947 in Stockholm under the heading »arteriosclerosis» and »myocarditis chronica». The latter diagnosis he mainly considered to be one of arteriosclerosis of the coronary vessels. From 1928 to 1941 there was a definite increase in the frequency which Henschen considered depended upon the two diagnoses coming into vogue. During the critical period of 1941 to 1944 there was a marked decline and then again a definite increase which could have a certain connection with a number of arteriosclerotics, who were given a new lease on life owing to the changed living conditions during the war years, but who had now died of their arteriosclerosis. During the period 1928—1941, there was a lowering of the total mortality both in Stockholm and in the whole country particularly noticeable during the war years and also during the economic depression in the beginning of the decade 1930—1939.

Björck and Blomqvist (1949) in their extensive statistical survey of the mortality in Sweden during the period 1911 to 1944 pointed out the downward trend in the total mortality, and besides this an increase in mortality caused by the cardio-vascular diseases. Considering the varying age-groups of the population and the change in the medical way of looking at things, and medical nomenclature, the authors were of the opinion that the mortality in cardio-vascular diseases showed a rising tendency deviating from the general course of development. It was found to be caused mainly by arteriosclerosis. Björck (1951) has later stated that about 40 % of the deaths in Sweden were caused by cardio-vascular diseases and that the main part was connected with arteriosclerosis. On account of the present increasing span of life it is expected, according to Björck, that the absolute and relative frequency of such diseases will increase uninterruptedly. This concerns particularly the morbid conditions related to arteriosclerosis.

The interest for cardiac infarcts among us seems to me to have

been created by Warburg (1930) in Denmark and by A. Jervell (1935) in Norway. Their investigations have given a clear description of the picture of cardiac infarctuous disease which has resulted in, among other things, a more general use of the electrocardiograph in our hospitals. Based mainly on hospital statistics it has been suggested that the reported increase in cardiac infarcts would point to a real increase in this disease among the population. This increase in frequency among the hospital clientele has been particularly noticeable during the post-war period.

Thus Brahme and Ahlberg (1947) have described a definite annual increase on material collected during a 20-year period in the Hospital of Norrköping with a definite annual increase of cardiac infarcts especially after 1938 with special emphasis on the last two years, 1946 showing a maximum with 29 admitted cases. They maintain that this could not altogether »be explained by an increased attention to this disease, nor due to the greater number of old people». Statistical calculations made by two insurance companies led them to the conclusion that there was a real increase in the whole country of cardiac thrombosis cases; »that arteriosclerosis had increased particularly among the town population, and cardiosclerosis, according to one insurance company, particularly among their clientele of well-to-do people who also represent a psychically hard-pressed stratum of the population».

Malmros (1949) reported a steady increase after the war in the frequency of cardiac infarcts admitted to Örebro County Hospital. In 1948 the number of admitted was 130 as against 20 to 25 cases per annum before the war and during the first war years. Malmros considers that this increase can hardly be apparent only and depending on a more correct diagnosis. A questionnaire sent out by him to a number of hospitals in Sweden, Norway and Denmark regarding cases of cardiac infarct admitted during the period 1939—1948 revealed an increase after the war, most marked in the two first-mentioned countries. In Sweden and Norway the number of deaths from this disease diminished during the war years while this was not the case in Denmark, where the mortality figures for cardiac infarcts were high all the time.



I have already mentioned the observations of Henschen regarding the decrease in mortality figures for arteriosclerosis in Stockholm during the war years 1941—1944. From Finland Vartiainen and Kanner (1947) reported that the autopsy material in Helsingfors showed a decrease in arteriosclerosis during the war with a definite decrease of grave types such as cardiac infarcts and cerebral haemorrhages in middle-aged patients. Similarly in Norway where the mortality figures in cardiovascular diseases decreased markedly during the war time of 1941—1945 only to increase again reaching the same figures as for the pre-war period (Strøm and Jensen 1950).

The differences and fluctuations in the mortality figures related to vascular diseases, as mentioned above, have been considered due to altered nutritional conditions with special reference to the lower mortality during the war years, noted for their poor food supply. Malmros (1950) made a comparison between mortality in arteriosclerosis and availability of food supply in the nordic countries and the U. S. A. for the period of 1935—1947. He found that in the U. S. A. where the supply of food material was good during the war period, an increasing mortality figure in arteriosclerosis was noticeable during the whole time. In Denmark, where the total fat consumption decreased during the war, but where the consumption of butter and eggs increased, there was no decrease in this mortality while there was some increase after the war. In the remaining nordic countries where, during the war years, there was a diminished consumption of eggs, butter and other food stuffs rich in cholesterol, the mortality figures of arterio-cardio-sclerosis dropped. Malmros maintains that the fluctuating mortality of arteriosclerosis and the frequency of cardiac infarcts, the fundamental cause of which is arteriosclerosis, would primarily depend on a greater or lesser consumption of cholesterol-containing food stuff based on the assumption that cholesterol would give rise to arteriosclerosis. He warns against high consumption of milk, butter and other animal fats.

## Chapter 2

### *The Pathogenesis and Complications of Arteriosclerosis The Question of Food*

As the close connection between arteriosclerosis and cardiac infarct seems to be elucidated, and as the stated importance of food and especially its contents of cholesterol should be of significance for deciding the genesis and complications of arteriosclerosis, I shall go more into details when dealing with these questions.

I wish to mention that I understand the word arteriosclerosis as defined by Marchand and described by him as arteriosclerosis with plaque formation, a condition which is characteristic of the changes in the coronary arteries in cases of cardiac infarct. It affects particularly the intima with a thickening of the coat and with a more or less advanced protrusion into the arterial lumen; typical also is a lipid deposit placed sub-endothelially in the reticulum of the tissues as well as intracellularly coupled with degeneration of the tissues and a process of fibrosis (atherosclerosis). Even though the early changes may show signs of regress this vascular disease is characterized by its progressiveness leading to stricture of the vessels, necrosis, erosion and calcification with accompanying complications such as occlusion, thrombosis with emboli, production of aneurysm and rupture. In addition the arterial lumen may wholly or partly be occluded by atheromatous masses or intramural haemorrhages from ingrowing capillaries. The atheromatous patches contain, among other things, cholesterol and esters of cholesterol, phospho-lipoids, neutral fat and fatty acids.

#### *a) The Importance of Cholesterol*

Cholesterol has been considered of utmost importance in giving rise to arteriosclerosis and its development. A good knowledge of the cholesterol metabolism is of great importance for the understanding of this problem (see Schettler 1952). Schettler points out that in the same way as cholesterol influences the metabolism of proteins, carbo-

hydrates, vitamins, minerals, hormones and water, the fats in particular, other changes in the total metabolism or separate metabolites affect the cholesterol metabolism. It may be noted here that cholesterol is present in all body cells and fluids. We receive it with our food and it is synthesized in different tissues of the organism. It may be totally used up or transformed in the body or eliminated; consequently it is not an end-product (Schettler 1952).

According to Bloch and Rittenberg (1942) cholesterol can primarily be obtained from acetate. The splitting up of fatty acids should thus be of importance in the production of cholesterol. The liver and the suprarenal glands are the foremost seats of production of blood cholesterol. It may also be produced from acetate in surviving arterial tissues of animals (Siperstein et al. 1951).

Animal experiments have shown that abundant cholesterol supply in the food lowers the cholesterol synthesis of the liver (Gould and Taylor 1950, Pihl 1951) but does not affect or very slightly so the cholesterol contents of blood in man. Man's daily liver synthesis of cholesterol (London and Rittenberg 1950) exceeds the quantity which is consumed on an ordinary mixed food intake. In case of increased cholesterol supply with the food it has been observed in rats that an increased breaking-up is taking place (Cook, Polgar and Tomson 1950). The cholesterol supply of the organism is maintained by the endogenous synthesis independent of the alimentary cholesterol (Schettler 1952).

The resorption of cholesterol is enhanced by fat. A state of fine emulsion raises the rate of resorption of fat; bile acids, and also addition of cholesterol do this. The greater part of the cholesterol secreted with the bile is again resorbed by the small intestine. Part of it is eliminated through the large intestine and the skin.

In order to study the metabolism of cholesterol the contents of cholesterol in the blood is of importance. Partly it is found in a free state, partly as cholesteroesters, in either form mostly together with other lipoids joined with proteins to form lipo-protein molecules. The greater part is localized to the  $\beta$ -globulin of the serum proteins (Blix, Tiselius and Svensson 1941). Cholesterol is also contained in the chylomicrons, big lipid particles with a great amount of neutral fat,

typical of lipaemic conditions. The cholesterol content of blood may normally fluctuate within fairly wide margins with an average figure of about 200 mg %. A disturbance of the normal lipid metabolism may result in not only a hyper-cholesterolaemia but also in changes relating to alteration in the blood lipoids and their mutual relations.

It has been suggested that cholesterol might give rise to arteriosclerosis by its entry alone, or with joint components from the blood stream, into the arterial wall where it is deposited and gives rise to processes of reaction in the tissues. That radioactive cholesterol passes from the blood into atheromatous patches has been proved by Biggs and Kritchevsky (1951). It has been observed that other colloids also are able to enter and be deposited in the intima. A high cholesterol content of the blood should particularly assist the formation of atherosclerotic patches.

Based mainly on the observation of Windaus (1910) who demonstrated a definitely increased occurrence of cholesterol in the atheromatous aortic wall as compared with the normal, and Anitchkow's (1913) well-known experiments on rabbits fed on cholesterol gave rise to the theory concerning the importance of cholesterol producing arteriosclerosis. These experiments led to hypercholesterolaemia and atherosclerosis. In spite of certain differences one has wished to compare this experimentally produced atherosclerosis with human arteriosclerosis. Support for hypercholesterolaemia producing arteriosclerosis has been substantiated by finding certain diseases such as essential xanthomatosis (Müller 1938), myxoedema, nephrosis and diabetes mellitus, which usually run a course with high cholesterol contents of the blood and often are accompanied by early and grave arteriosclerosis. In addition it has been found that the cholesterol content of the blood usually increases with advancing age (Schettler 1953, and others) which should explain the fact that the arteriosclerosis very often increases in old people. The many experiments which have been undertaken to establish a connection between arteriosclerosis and cholesterolaemia have, however, not led to final and decisive results. The arteriosclerosis is not confined to old age and the gap has not been bridged between the relatively small group of diseases mentioned above and the great number with normal cho-



lesterol content of the blood from which the majority of arteriosclerotic victims come (Gofman et al. 1950). According to Moses (1953) the range for the cholesterol figures in normal people and that in arteriosclerotic persons cover each other to a considerable degree. Yater et al. (1948) could not prove a raised cholesterolaemia being the rule even in cases of early and grave, fatal coronary sclerosis in young men. In addition may be mentioned that Tannhauser (1952) considers that the essential familial hypercholesterolaemia is a disease of the metabolism of cholesterol, which may, however, lead to a deposit of cholesterol in the cells of the intima, but should be differentiated from the ordinary arteriosclerosis. From what has been said it would be evident that the increased cholesterol content of the blood alone cannot be considered a decisive factor in producing arteriosclerosis.

Further, it has been put forward that it is not the cholesterol content which is the most essential but that the penetration of cholesterol into the arterial wall should be guided by certain conditions which are concerned with the colloidal components of the blood; the size of the lipid components are of importance, their make-up and the colloidal stability of the serum. Gofman et al. (1950) were able to demarcate, by means of ultracentrifuging, certain high-molecular cholesterol-carrying lipoproteins ( $S_f$  10—20) in the blood which seemed to have greater correlation to arteriosclerosis than the total quantity of cholesterol. On a diet poor in cholesterol and fat (Gofman et al. 1950) and by giving intravenous heparin injections (Gofman et al. 1951) the contents of these molecules in the blood could be brought down. Earlier Hahn (1943) had demonstrated that injections of heparin also reduced alimentary lipaemia. The significance of the Gofman-molecules has been contradicted by Keys (1951) who pointed out the exact relation between the contents of total cholesterol and these molecules. Moreton (1947) is inclined to connect the development of arteriosclerosis in predisposed individuals with the alimentary lipaemia which occurs after a meal rich in fat in which case the great chylomicrones are of importance as carriers of cholesterol. Ahrens and Kunkel (1949) showed, however, that arteriosclerosis does not threaten in case of hyperlipaemia where the phospho-lipoidal

content is high in relation to the cholesterol content. They explain this by stating that the phospho-lipoids have a stabilizing effect on neutral fats as well as on the cholesterol of the blood. In spite of the high contents of these products the serum is clear in case of high phosphatide content. — Malmros and Swahn (1952) desire, however, to include the essential hyperlipaemia among the conditions which encourage arteriosclerosis. They base their opinion on electrophoretic examinations which, in these cases showed, beside a high peak of chylomicrones, particularly high lipid values in the  $\beta$ -globulin fraction. In diseases with a tendency to arteriosclerosis and in case of cardiac infarct there was a high  $\beta$ -peak in the lipid curve even where the cholesterol content was normal. — Pollak (1951), who also stresses the importance of  $\beta$ -globulin in case of arteriosclerosis and its development, emphasises that the serum albumen acts as a protective colloid for cholesterol or for the cholesterol-globulin complex. He maintains that hypoalbuminaemia and hyper  $\beta$ -globulinaemia should be decisive for the penetration of the lipoprotein molecules into the vessel wall. — Finally it may be mentioned that Russ et al. (1951) found a tendency towards reduction of albumin and  $\alpha$ -lipoprotein with an increase of the  $\beta$ -lipoprotein in the blood in case of arteriosclerotic disease without accompanying hypocholesterolaemia or raised quota of cholesterol-phospholipoids. They demonstrated also a higher content of  $\alpha$ - than  $\beta$ -lipoproteins in the blood of young women as a contrast to normal men and women of the age-group 45—65 years. Barr et al. (1952) consider that oestrogene hormones should play a part in this and be the explanation of arteriosclerosis being less common in younger women than in men of the same age.

Hereditary, nutritive, hormonal and functional factors of the liver are included in the conditions, which, according to what has been mentioned above, are connected with such a composition of the blood lipoids that they influence the arteriosclerosis. Whatever may be the cause of this, be it one or several of these factors, it cannot be decided at present. Further, it may be mentioned that we have to count with other etiological factors being present which will be dealt with below. From what has already been referred to above, it becomes clear that a specific etiology cannot be given and especially that even if

the blood lipoids have an etiological significance for the production of arteriosclerosis this can only be one factor among others.

That different factors are of importance in the development of experimental atheromatosis in animals is evident from the different means, both mechanical and chemical, by which it can be produced or prevented. The varying result of cholesterol feeding in different types of animals is striking. The various experiments performed to alter the lipid metabolism in order to prevent atheromatosis, e. g. the use of lipotropic substances and the stabilizing of the blood lipoids (Pollak 1951, and others), the use of heparin (Graham et al. 1952), of vitamin E (Holman 1949), of hormones, also of cortison and ACTH (Oppenheim and Bruger 1952), have all suggested the recommendation of certain substances as antisclerotics in man as well. As regards some of these substances it can be said that they have not stood the test in a critical follow-up and that the trials for which some of them have been used on man do not render a definite opinion as to their efficiency. It must be admitted that the information gained through animal experiments has been of great value in our understanding of the human arteriosclerosis, its origin and development. It is our hope that in spite of the non-physiological aspect of many of such experiments and in spite of the experimental atheromatosis in animals being different in comparing it with the human type, our knowledge may be enriched from such experiments which lead to practical and clinical results with regard to arteriosclerosis in man as well.

### *b) The Condition of the Arterial Wall*

The tendency to arteriosclerosis in certain diseases, and with advancing age, suggests that there are certain factors present in these conditions which favour the development of arteriosclerosis. It has been noted already that causes other than the blood lipoids have to be considered. The condition of the vessel wall is definitely of importance. With advancing age there is a diffuse alteration on a colloidal basis taking place in the arteries as well as in all other tissues. This leads to a fibrosis and a thickening of the various layers of the wall and a lowering of the elasticity with a widening of the lumen

vessel, to a lengthening and tortuosity of the vessels and, in addition, a deposit of lipoids and calcium and other substances as well in their respective walls. These changes are particularly evident in the media. It must also be considered that the above mentioned diseases with a tendency towards arteriosclerosis like toxic products of different genesis cause alterations in the different layers of the arterial wall on account of osmotic disturbances. Even mechanical action caused by the pressure of the blood stream most likely produces changes in the vessel wall. This may be particularly prominent within certain sections of the vascular system. A general increase in tension, as in hypertonia and in conditions of nervous origin enhance the mechanical influence and the changes in the vascular wall. The disturbances of the tissues in the vessel wall produced by these various agencies give rise to the process of sclerosis which, according to Schettler (1953), is characteristic of arteriosclerosis. Schettler emphasizes further that it is this primary damage to the vessel wall which is the main cause of the arteriosclerotic plaques formation occurring in man.

The tendency of these arteriosclerotic plaques to originate, and in various degree of development, in different vascular areas point to local causes playing their part. It may be a question of anatomical relation as well as certain properties in the vessels themselves. The condition of the blood stream must be taken into account as the plaque formation is very frequently observed at points of ramification. Places in the vascular wall especially subjected to pressure appear to be predisposed e. g. the aortic arch and where the vessel is firmly attached, further in front of a coarctatio aortae and in the pulmonary artery during increased pressure inside the pulmonary circulation. Even inflammatory processes play their part. Lues, for example, may produce a limited area of destruction in the vessel wall resulting in localized arteriosclerotic changes.

That the extra-mural coronary vessels are particularly prone to arteriosclerosis has been explained by the great variation in blood pressure in these vessels during systole and diastole. The branches of the left side are subjected to higher pressure. Hence arteriosclerosis is more evident in these (Horn and Finkelstein 1940) where it also appears earliest, being localized to the proximal parts. French



and Dock (1944) found in young soldiers, death due to coronary sclerosis, that in most cases the greatest vascular change was seen in the downward branch of the left coronary artery. It may be noted that this branch leaves the aorta at an angle of 180 degrees, while the other branches form an angle of 90 degrees, and this makes it more exposed to the traumatic influence of the blood stream. Lundquist (1950) has published his observation on 69 post-mortem cases, death due to acute cardiac infarct, most of them men, that the diameter of the left coronary artery showed an average size of 4 mm against 4,5 mm for the right one.

The characteristic of the patchy arteriosclerosis is the infiltration of cholesterol into the intima and the development of atheroma. How this transformation into cholesterol takes place, and what the cause of it may be, is not yet clearly understood in spite of what we know in this matter. Meyer (1952) maintains, relying on pathologico-anatomical observations, that the lipoid-infiltration is of a secondary nature. He points to the primary importance of the pre-sclerotic reaction of the intima caused by proteins which infiltrate with the plasma from the blood stream and leading to the sclerosis proper. Injury of various kinds and mechanical influence which affect the vessel wall are thought to be the cause of this process. The damaged oedematous parts of the intima are also plausible seats for lipoid deposits. It may be surmised that the lipoids and the proteins at the same time enter the arterial wall as the blood seeps in («insudates») but the reaction of the intima may occur without a deposit of lipoids. Meyer refutes the idea of a primary lipoid deposit in an undamaged intima being the cause of an arteriosclerosis and points out that the not uncommon patches of the intima rich in lipoids, and seen in early childhood, may remain for decades without producing a noticeable formation of connective tissue; most likely they disappear without any fibrosis. To compare the experimental atherosclerosis with the human patchy arteriosclerosis appears to this same author to be wrong because the sclerotic changes of the intima in man precedes that of the lipoid infiltration. It may be noted here that Duguid (1949) maintains, based on physiological principles for the vascular function, that the fundamental in producing arteriosclerosis is not

to be found in fibrous hyperplasia which ought to lead to a vascular dilatation. He considers that it is the stricture of the lumen being the characteristic which is so often seen in middle-sized vessels, such as the coronary arteries. According to Duguid this arises from thromboid masses becoming covered with endothelium and changing into fibrous tissue, and this may become vascularized or may show fatty degeneration, calcification and erosion. It may be a question of an occluding thrombus which becomes fixed to the wall and canalized, but most common is the microscopically small or larger pavings on the intimal surface which later give rise to the fibrous thickening of the wall. The progressivity can be explained by thrombus formation becoming a recurring process. The thrombus formation Duguid explains as due to fatty degeneration of the intima leading to erosion coupled with a pathological tendency to thrombus formation. According to Mayer, who agrees that the sclerosis of the intima may be caused by a thrombus in the wall, the primary reason resulting in damage to the wall is to be sought in the oedema of the intima with subsequent thrombus formation. He emphasizes, however, that the sclerosis of the intima is not conclusively dependent on such formation of thrombi.

Though it cannot be proved that a primary cholesterol infiltration into an un-damaged intima should be the cause of arteriosclerosis in man it seems feasible that its presence in atheromatous patches may become of deleterious influence to the development of arteriosclerosis and its clinical manifestations. Cholesterol present in these patches may have entered from the blood stream but it seems also plausible that it may form in the vessel wall itself. In agreement with Schettler (1953) one is inclined to endorse the relation between the metabolism of cholesterol and arteriosclerosis and that certain conditions point to the fact that longstanding hypercholesterolaemia may produce additional damage to blood vessels already primarily injured or altered. It must be pointed out that there are arteriosclerotic vessels rich in cholesterol even with normal or low cholesterol content of the blood. Cholesterol cannot be of final and decisive importance in producing arteriosclerosis. There are several co-operative factors contributing.

### c) *The Influence of Food*

The decrease of arteriosclerosis observed in Germany during the years of famine following the first World War may, according to Aschoff (1930), be due to a lack of cholesterol in the food. He refers to the observation regarding the reversibility of atheromatosis in animal experiments by excluding cholesterol on the supposition that atheromatosis in man could be checked as well. Earlier in this work observations which suggested a connection between arteriosclerosis and food have been alluded to. Malmros (1949, 1950) has in particular laid emphasis on food rich in cholesterol. From reports enriching our knowledge of the cholesterol metabolism it is difficult to prove the dependence of arteriosclerosis on the cholesterol quantity in food. Some observations even contradict this connection. It ought to be mentioned that Gertler et al. (1952) do not find any correlation between coronary sclerosis and cholesterol consumption.

On the other hand, earlier descriptions have suggested a certain connection observed between cholesterol in the blood and arteriosclerosis. While even great variation as regards quantity of cholesterol in the food seems to have only a slight influence on the cholesterol-content of the blood it may be appropriate to recapitulate the effect of fat on cholesterol metabolism. The cholesterol content of the blood may be considerably lowered by a diet devoid of cholesterol and fat and it may again be raised by consumption of fat, even vegetable fat which does not contain cholesterol. Fat seems to supply acetate for the synthesis of cholesterol in the liver (Keys et al. 1950). It may also be mentioned that Schettler (1953) noticed a decrease in the blood cholesterol during the austerity years after the second World War in Germany. He is of the opinion that this does not depend on a deficient cholesterol supply but from a lack of all food stuffs, particularly fats and proteins.

The importance of exogenous fat and its influence on arteriosclerosis should thus come to the foreground. But the question is thereby transferred to a matter of calories and nutritional conditions. A meal rich in fat is usually supposed to be of high caloric value. Ström and Rygh (1952) in their work critically oppose that of Malmros and

maintain that what characterised the mortality in heart- and vascular diseases in Norway during the period 1938—1947 was the correlation to caloric use. An investigation of the content of cholesterol in Norwegian food stuff and fare for the period 1940—1945 caused Pihl (1952) to draw the conclusion of the improbability of the reduction in cholesterol consumption during the war being responsible for the decrease in cardio-vascular disease during that time. This downward trend started already in 1941 when the cholesterol consumption was only slightly reduced. Referring to our knowledge of cholesterol metabolism Pihl considers that the reduction in fat consumption and caloric supply were of greater importance than the cholesterol reduction. By his analysis of cholesterol in different food materials he found that animal fat contains only slightly more cholesterol than leaner food (such as fish) and that fat and milk have a relatively low cholesterol content from the caloric point of view.

A similar way of reasoning is that of Borgström (1951). He points to the fact that most animal food stuffs contain cholesterol and that the average Swede consumes more cholesterol through meat of various kinds than in the form of eggs in spite of the higher cholesterol content of the latter. For several reasons mentioned he considers fat more compromising than cholesterol, and points out the greatly increased consumption of cooking fat in Sweden particularly after all rationing ceased.

#### d) *Obesity and Arteriosclerosis*

It is commonly considered that there is a connection between arteriosclerosis and the condition of nutrition. There are certain difficulties, however, of proving this clinically. An autopsy material Wilens (1947) showed that obese persons above the age of 35 suffered from grave arteriosclerosis in higher frequency than people of medium weight or lean irrespective of age, sex, hypertonia, size of heart and diabetes mellitus. The figures published by the life insurance companies speak also of an over-mortality in cardio-vascular disease combined with obesity. Armstrong et al. (1951) pointed out in life insurance statistics a decided over-mortality particularly among men



suffering from a pronounced degree of obesity. Among different diseases degenerative diseases of the heart, blood vessels and kidneys contributed most to this over-mortality. Both men and women showed a 70 % higher death-rate from these diseases than was otherwise expected.

There is at present an uncertainty as to what favours the development of arteriosclerosis in the presence of obesity. Obesity in itself does not appear to cause this affection, nor under all conditions. Nordlander (1953) is of the opinion that the greater frequency of arteriosclerosis in obese people is most likely connected with an alteration of their fat metabolism. The pre-requisite for a nutritional disturbance in the vessel wall by altered metabolism, or caused by local conditions, may be considered present. The usual combination with hypertonia may be pointed out. Irrespective of age and sex there is, according to Master et al. (1950), an increased blood pressure in proportion to the increased body weight in types of different height.

In what way and to what extent food should be the cause of this connection between obesity and arteriosclerosis has not been made clear. It may be remembered that a rich fatty diet does not necessarily mean a rich cholesterol intake but the assumption is there that fat, which favours the resorption of cholesterol of the food, may give rise to increased cholesterol production after splitting into acetate. Further, it may be assumed that calories in excess wherever they may come from may transform into fat. Experiments with inanition of rats proved a decrease of the cholesterol synthesis in the liver but carbohydrates, proteins as well as fat stimulated the cholesterol genesis to about the same extent later (Tomkins et al. 1952).

That a diet rich in fat and meat is not in itself decisive for producing arteriosclerosis appears clear from the investigation made by Ehrström (1950) on the inhabitants of north Greenland who mainly live on this kind of food. Clinical manifestations of arteriosclerosis were not particularly evident among them. Similar views apply to our Swedish lumbermen who consume a large amount of fat. Boalt and Zotterman (1943) found that lumbermen from the province of Värmland lived on a daily caloric supply of 5900 out of which 26.5 % from fat. The net usage was, however, 5000—6000 calories per 24

hours (Zotterman and Lundgren 1948). The consumption of the number of calories supplied may be considered a decisive factor.

When the dietetic importance of carbohydrates in the treatment of adipositas is now placed in the foreground on account of their causing a prevention of ketosis which stimulates the breaking up of fat (Pennington 1953), it is of interest to point out that already in the »Banting Diet Cure for Obesity» as communicated by Hedenius (1865) it was included as an important factor to reduce the intake of carbohydrates, according to Liebig the so called respiratory means. They were considered to be on the one hand convertible into fat, on the other hand able to prevent fat metabolism.

Considering these statements regarding the connection between food, obesity and arteriosclerosis it seems to me that we must conclude that in case of arteriosclerosis and conditions with a tendency to arteriosclerosis, where obesity may be included, caloric supply in excess and likewise fat is more important than the consumption of cholesterol.

In an attempt to find an explanation of the fluctuation in the frequency of arteriosclerosis observed and particularly noted as fluctuations in the mortality caused by arteriosclerosis in a population, there are several causes to be mentioned. The difficulties in deciding these causes depend to a great deal on the fact that early clinical signs of arteriosclerosis do not become evident until the process is already well advanced. It has already been pointed out in the discussion on the genesis of cardiac infarct that functional factors play a considerable part in the production of symptoms. This applies also in considering the mortality of cardio-vascular disease which is dominated by arteriosclerosis.

Moses (1953) points out when referring to animal experiments that arteriosclerotic damage to the vascular wall may develop in a short time; it is not necessarily a question of months or years. He suggests hypertonia caused by stress, or some other factor such as obesity. The opinion of Duguids (1949) may also be recollected where he maintains that constrictions of the vascular wall are often results of mural thrombi. Different theories on the cause of these have already been discussed. I wish to emphasize that an increased ten-

dency to thrombus formation seems to be connected with nutritional conditions. Jensen (1952) found that the number of cases of thrombo-embolic complications were definitely reduced in number in the surgical clinics in Oslo during the war years, only to increase again later on in spite of prophylactic precautions being taken. We are familiar with the combination of obesity and thrombosis.

Apart from the above mentioned risks obesity causes the arteriosclerosis to progress, and from a functional point of view it is also factor of strain and stress on the cardio-vascular system resulting in symptoms of insufficiency. This has clearly been demonstrated by Nordlander (1953). A case of grave adipositas in a man, aged 28, who died from cardiac insufficiency with fatty degeneration of the myocardium but with normal coronary vessels, published by Lodin (1953), may be mentioned in this connection. It may be considered as very likely that an increased body weight as an additional factor has influenced the rising tendency of cardiac infarct which has been observed as resulting from improved nutritional conditions after the war. This also seems to account for the increased mortality in cardio-vascular diseases.

As an explanation of the relatively rapid descent in the mortality statistics for these diseases, which was observed during the period of food restriction, a diminished development or regress of arteriosclerosis can hardly be given as a due cause, in any case not with reference to the fibrous alterations. On the other hand factors diminishing the consequences of arteriosclerosis ought to be emphasized. Functional means may then be of definite importance such as diminished strain and stress in reverting obesity. A decreased tendency to produce cardiac infarct during weight-reducing from lack of nourishment should also be referred to this as well as the lower number of deaths from cardio-vascular diseases.

With reference to what has been already said it must be mentioned how difficult it is to judge from the mortality statistics on cardio-vascular diseases if arteriosclerosis is diminishing or increasing among a population even if the altered average age is considered. Various factors of functional importance may be added which may be observed and judged clinically and they may even influence the mortality fi-

gures of arteriosclerosis without any necessary changes as to the severity or frequency of arteriosclerosis. Alterations in the nutritional status belong to this group.

Henschen (1950) maintains in discussing the problem of arteriosclerosis that arteriosclerosis deserves the name senile disease because it leads to a premature ageing, but it is not an obligatory senile change. According to him there are endogenous, constitutional factors which are mainly the cause of this disease. As an experienced pathologist he comes to the conclusion that arteriosclerosis is more common and occurs at an earlier stage and more pronounced in obese people, in those with hypertonia, in diabetics and in cases of hypothyreosis but less pronounced in lean people, even in those who are lean on account of chronic tuberculosis or cancer and in those suffering from hyperthyreosis. Henschen further stresses the connection between food and arteriosclerosis. I have referred to the opinion held by Henschen as this essentially conforms with my own findings, and because it also forms, to a certain extent, the basis of dealing with the material in this work.

What has been stated above is in itself a starting point for evaluating the material which has come up for investigation of the infarct cases at Umeå Central Hospital. There is, however, another factor still which I would like to point out and which, having mentioned Henschen (1950), is of importance when considering this material, namely, the geographico-pathological factor. There seems to be no question of race as to disposition but a low frequency of arteriosclerosis in populations who live on vegetarian and lean food and who are of lean stature (Wilens 1947 and others). High frequency of arteriosclerosis has been reported among nomadic Kirgis tribes where obesity is common on account of particularly heavy consumption of food stuffs containing mutton and fermented mares' milk (Kuczynski 1925). Keys et al. (1952) have found a relatively higher consumption of fat in populations in the U. S. A. and in countries of northern Europe than in Naples where arteriosclerosis occurs in a lesser degree. From the work of Lundquist and Björnwall (1936) it was shown that arteriosclerosis occurred in a considerably smaller degree in the autopsy material from Umeå Central Hospital 1933 both as to frequency and



gradation than at the autopsy examinations in Lund and Stockholm. 80 % of the Umeå autopsy material came from the coastal population of the county of Västerbotten, where according to Odin's (1934) recently made investigations the food consisted mainly of a monotonous diet of milk and flour poor in calories.

## PART II

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### *Cases of Cardiac Infarct admitted to the Department of Medicine at Umeå Central Hospital 1939—1950*

Stimulated by the investigation of Lundquist and Björnwall (1936) reporting a low frequency of arteriosclerosis in the Umeå material and with a knowledge of the close connection between arteriosclerosis and cardiac infarct, it struck me as being of interest to investigate if and to what extent our relatively low hospital frequency of cardiac infarct was related to the low frequency of arteriosclerosis among the population, and if so what the cause of this could be; if the increased number of cardiac infarct cases was due to an increasing arteriosclerosis, if so the cause hereof; if other reasons might be found for the low and the rising frequency of cardiac infarct and if there was, in addition, something noteworthy regarding the cardiac infarcts in particular when comparing them with what is known from more southern parts of our country.

# Chapter 1

## *The Population, Living Conditions etc.*

The receiving area of Umeå Central Hospital consists of the southern and western parts of the county of Västerbotten. Its southernmost point is 63.5 deg. north and extends from the coast of the Gulf of Bothnia to the frontier of Norway in the northwesterly direction. Farthest north it reaches 66.3 deg. north. In the 60 Km. wide coastal area which is mostly plains with a great deal of forest, most of the agricultural land is found, and most of the industrial work, though this is relatively insignificant. From there extends a wide area of deep forests with cultivated stretches along the rivers. Here the lumber industry is predominant. Farthest in the northwest are mountainous regions. The distance from the Umeå Central Hospital, situated on the east coast, to the farthest mountain villages is about 400 Km. Within the extensive receiving area of the Hospital there are some smaller cottage hospitals for acute cases. The railway- and road-net work is rather sparse, the roads connecting villages and homesteads with the highways are not seldom of poor quality. Transport to the Hospital is therefore many times long and tiresome for the sick people. They are particularly trying during the long and cold winters but the transitional periods in spring and autumn often make the roads very difficult to negotiate.

It is a sparsely populated county. The density of the population showed a figure for 1949 of 4.2 persons per square kilometer. Within the receiving area it is greatest in the town of Umeå and neighbouring parishes where a third of the areapopulation lives. The total number of inhabitants of the whole area was 145309 on 1. Jan. 1951.

The population is decidedly of Swedish extraction. There is a sprinkling of Finns, and in the mountains there is a small Lapp tribe, and also some intermarriage between Lapps and Swedes.

On the whole the population is stationary and this applies particularly to the country folk. There is a relatively small moving in of people from other parts of the country and when it occurs it affects the larger communities only, the industries and the towns. To these

places, as in the rest of the country, there is a transfer of population within the country from countryside to towns mostly of people in their active years. Since far back the county has experienced a similar moving out. An increase of the population is still taking place, chiefly due to a higher birthrate. On 1. Jan. 1943 the census figure for the county was 217740 as against 231740 on 1. Jan. 1951. According to the report from the Ministry of Health for 1950 one can draw the conclusion that there is a steady increase of old people in the country, which figure is increasing more rapidly than that of the total population and is more evident in this county than in the rest of Sweden; this is true both as regards towns and countryside, and also for men and women. To this may be added that here is a comparatively large number of middle-aged persons due to a higher birth-rate and less moving out from the countryside as compared with that in the more southern parts of the country.

The county of Västerbotten is mainly agricultural. The proportion of agriculturists to the total population has, however, diminished as in the rest of Sweden (Granström 1942). 1940 57.4 % of the population of the county were occupied in agricultural work or ancillary trades. 1945 the same figure was 53.1 %. Corresponding figures for the whole of Sweden were 31.9 and 28.2 % respectively. Foremost among the subsidiary means of livelihood is forestry. The agriculturist is, as a rule, also a lumberman in order to safeguard his supply of cash income. The climate and the small homesteads (an average of 11.75 acres arable fields per unit, in the Lapp area 6.5 acres) decide the type of agriculture which is mainly directed towards keeping cattle and running dairies. Barley and potatoes are produced in sufficient quantities for consumption within the county, but wheat and rye have to be imported. As regards meat the county is self-supporting and this very nearly applies to pork as well. Eggs are sometimes imported but the production is at other times large enough to allow export. The county has an excess of butter and cheese and exportation of these essentials is taking place.

As a whole it can be said that agriculture has progressed steadily since the »Norrländ Investigation» took place some 20 years ago. Farming has been developed and farm-produce has greatly improved.



Improved conditions and cattle-breeding (according to reports from The Västerbotten Butchers' Association) have resulted in the average weight of beef animals increasing from 119 Kg in 1939 to 147 Kg in 1952. Through the Butchers' and Dairy Associations who even allow a sale back of animal produce at a lower price, a more stable income has been assured from farming. The economic standard of the farmer has also been raised. The isolation of the villages has been broken. All this together with an increased general knowledge has resulted in more varied food, and more sensible than earlier. The monotonous diet made up of milk and flour, so common particularly among the population of the coast, does not exist to the same extent or nearly so often. Milk- and flour produce such as milkcurds and crispbread appear to me, however, as being used in considerably larger quantities in the homes of the farmers as compared with their use in more southernly parts of the country. The consumption of potatoes is heavy. The previous consumption of pork, a monotonous diet in great quantity, which supplied a daily caloric value of about 5000 — a diet common among the lumbermen who used about 200—300 gm of fat, mostly in form of pork, is a thing of the past. In the farmers' homes it is now common to find both meat and pork although not every day and not in the same quantity as is the custom in the »fatter» provinces. Butter is being used more commonly and in fair amounts, margarine to a relatively less degree, and eggs still less. Ready-made foodstuffs such as sausage and salted herring, dried fruit and sugar are used more frequently. The consumption of sugar is fairly heavy. Fresh fruit and vegetables are used more sporadically.

The past 20 years have seen a definite adjustment thus making the food arrangement in the country areas more like that of the rest of the county population and of that enjoyed by folk of more southern provinces. The nutritional value of the food as well as the number of calories supplied are bound to have increased where previously it was low. Most of what previously was peculiar to the population of Västerbotten as regards food and living habits has been given up. Considering prevailing conditions it is evident that the farming population does not live in abundance, in some places it may be the very opposite. Though mechanization has made work easier the lumberman

and farmer of Västerbotten have to work hard from early years to old age, and as a rule they are sinewy and lean.

In the towns and larger municipalities with their population of townsfolk, civil servants and industrial workers, the living conditions and food composition do not differ much from those prevalent in similar places elsewhere in the country.

The total mortality figure for the County of Västerbotten is lower than that of any other in the country. 1939 for the county it was  $10.51 \pm 0.22$  ‰ and for the realm  $11.52 \pm 0.042$  ‰; 1951  $9.34 \pm 0.20$  ‰ and  $9.85 \pm 0.037$  ‰ respectively. The lowering of the mortality figures noticeable in the country as a whole is also present here. It ought to be noted that the marked lowering of the mortality figures observed in the country during the war and the upward trend afterwards also took place in this county. The lowest figures of mortality during this period were for 1942  $8.78 \pm 0.20$  ‰ for the county and  $9.89 \pm 0.039$  ‰ for the realm.

In this connection it may be added that the war time austerity measures were certainly noticeable but they were of a lesser degree here than in the larger cities of other parts of the country. The farming areas in particular, where there was a fair supply of butter and meat, did not suffer much from food restriction with the exception of sugar.

## Chapter 2

### *Investigation of the Admitted Patients*

In the forthcoming discussion of the material I have not mentioned certain clinical facts regarding cardiac infarcts which are universally known. In this material they have not deviated from what is typical of the disease. Examining this material I have only included such cases where clinical as well as electrocardiographic examination or autopsy have with certainty proved to be infarcts. Only acute cases have been included and the cardiac infarct has in all the cases, where the patient died, been the cause of death. Relapsing cases have not been listed as new ones.

#### *a) Frequency of Admission, Mortality, Sex- and Age Distribution*

Table 1 shows that the total number of cardiac infarcts admitted during 1939—1950 was 232 of which 170 were men and 62 women. The distribution in percentage (Table 2) proves to be  $73.3 \pm 2.9$  % men and  $26.7 \pm 2.9$  % women, the proportion of admitted men: women equalled 2.6. Of those admitted 74 died, of which number 50 were men and 24 women. The total mortality amounted to  $31.9 \pm 3.1$  % out of which  $29.4 \pm 3.5$  % were men and  $38.7 \pm 6.2$  % were women, the proportion deceased men: deceased women 2.1: 1. The excess in number of admitted men to that of admitted number of women tallies with other statistical reports and corresponds with the risk of affection for men: women = 3 to 1 according to Master (1947). The figures of mortality are higher among women (38.7 %) than among men (29.4 %), figures which also tally with earlier reports (Master 1947). The average age (Table 1) among the admitted, deceased and alive, is lower for the men than for the women. The figures mentioned in the Table are more or less the same found in other comparisons, the same applies to the average age for the total of admitted and deceased (Brahme and Ahlberg 1947, Helander 1949, Wällgren 1950 and Wright 1948).

TABLE 1

*Admitted cases of cardiac infarct and deaths during each year  
1939—1950 with note on sex distribution and average age.*

a.

| Year  | Admitted |           |       |             | Deaths |           |       |             |
|-------|----------|-----------|-------|-------------|--------|-----------|-------|-------------|
|       | Total    | Number of |       | Average Age | Total  | Number of |       | Average Age |
|       |          | Men       | Women |             |        | Men       | Women |             |
| 1939  | 9        | 6         | 3     | 58,4        | 2      | —         | 2     | 70,0        |
| 1940  | 11       | 7         | 4     | 58,5        | 2      | —         | 2     | 62,5        |
| 1941  | 4        | 2         | 2     | 60,8        | 1      | —         | 1     | 58,0        |
| 1942  | 6        | 3         | 3     | 63,7        | 4      | 2         | 2     | 70,0        |
| 1943  | 16       | 11        | 5     | 61,4        | 3      | 3         | —     | 63,3        |
| 1944  | 18       | 14        | 4     | 60,0        | 5      | 4         | 1     | 61,0        |
| 1945  | 15       | 10        | 5     | 63,3        | 6      | 4         | 2     | 66,0        |
| 1946  | 15       | 11        | 4     | 61,1        | 7      | 5         | 2     | 66,3        |
| 1947  | 32       | 23        | 9     | 60,0        | 7      | 3         | 4     | 66,9        |
| 1948  | 22       | 20        | 2     | 57,2        | 7      | 7         | —     | 57,8        |
| 1949  | 38       | 31        | 7     | 63,3        | 13     | 11        | 2     | 66,4        |
| 1950  | 46       | 32        | 14    | 63,2        | 17     | 11        | 6     | 64,0        |
| Total | 232      | 170       | 62    | 61,2        | 74     | 50        | 24    | 64,6        |

b. Average age:

|                    |             |       |
|--------------------|-------------|-------|
|                    | Men         | Women |
| Admitted .....     | 60,1        | 63,7  |
| Deaths .....       | 62,2        | 65,3  |
| Survivors .....    | 59,4        | 62,7  |
| Age of Men .....   | 37—81 years |       |
| Age of Women ..... | 43—77 years |       |

TABLE 2

*Age distribution among the patients, with note on sex distribution  
and mortality in the age groups.*

| Age   | Admitted |      |       |      |       |      | Deaths |      |       |      |       |      |
|-------|----------|------|-------|------|-------|------|--------|------|-------|------|-------|------|
|       | Men      |      | Women |      | Total |      | Men    |      | Women |      | Total |      |
|       | Numb.    | %    | Numb. | %    | Numb. | %    | Numb.  | %    | Numb. | %    | Numb. | %    |
| < 40  | 1        | 0,6  | —     | —    | 1     | 0,4  | —      | —    | —     | —    | —     | —    |
| 40—49 | 26       | 15,3 | 5     | 8,1  | 31    | 13,4 | 6      | 23,1 | —     | —    | 6     | 19,4 |
| 50—59 | 54       | 31,8 | 11    | 17,7 | 65    | 28,0 | 10     | 18,5 | 3     | 27,3 | 13    | 20,0 |
| 60—69 | 53       | 31,2 | 31    | 50,0 | 84    | 36,2 | 17     | 32,1 | 13    | 41,9 | 30    | 35,7 |
| 70—79 | 35       | 20,6 | 15    | 24,2 | 50    | 21,6 | 16     | 45,7 | 8     | 53,3 | 24    | 48,0 |
| ≥ 80  | 1        | 0,6  | —     | —    | 1     | 0,4  | 1      | —    | —     | —    | 1     | —    |
| Total | 170      | 73,3 | 62    | 26,7 | 232   |      | 50     | 29,4 | 24    | 38,7 | 74    | 31,9 |



From Table 2 it is evident that the lower average age among the men is due to the preponderance of men under the age of 59. Only one person, a man, was under 40. The proportion of men to women in these lower age groups was 5 to 1, while that of the age of 60 and above was 1.9 to 1. In the seventh decade there was a preponderance of admitted women but above this age there was a levelling out of the sex frequency. That cardiac infarct in younger years is more common among men has been mentioned by, among others, Bean (1937) and Yater et al. (1948), while the preponderance of women in the seventh decade is more evident, but after this less noticeable (Bean 1937). It may also be noted that among the different age groups the greatest number of admitted patients was found in the seventh decade and the greatest number were above the age of 59. Mortality mounted with increasing age, equally for men and women, as is also seen in other statistical reports. Fatal results in cases under 50 years of age occurred only among men. The mortality figures for the age group 50—79 were in all respects higher among the women.

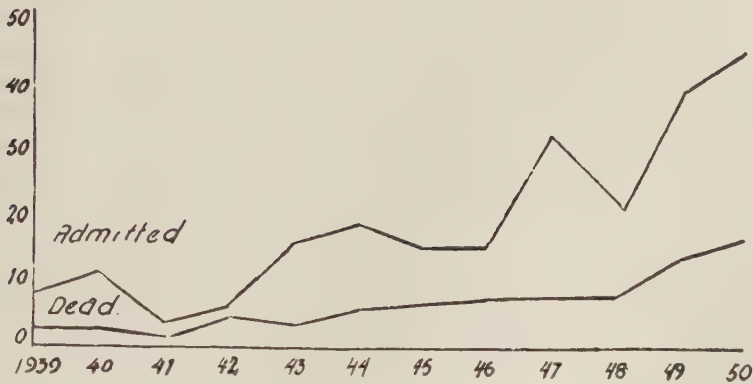
The graphs in this diagram (Fig. I) which refer to the figures of admitted patients and deceased noted in Table 1, show that the number of admissions was relatively low during the earlier part of the period with a slight lowering during the critical years 1941—1942, after this a rise particularly marked in 1949 and 1950. The number of deaths, which was low during the first years — the lowest figure of 1 in 1941, shows from then on a gradual rise and a definite increase during the last two years. This development, as noted on the diagram is on the whole in accordance with the findings of Brahme and Ahlberg (1947) and Malmros (1949) in their investigations regarding the occurrence of cardiac infarcts during this same period, but tallies also with the graph made by Henschen (1950) on the mortality in arteriosclerosis and myocarditis chronica. It is, however, evident that the figures for cardiac infarcts admitted in the Central Hospital of Örebro during the past few years are considerably higher than those for the Umeå Central Hospital. It may also be mentioned that Wällgren (1950) reported that the number of cardiac infarcts admitted in the Medical Clinic No. I of the Sahlgren Hospital at Gothenburg during 1948 amounted to 179 cases. If the greatest number of ad-

Fig. 1.

*Number of Cardiac Infarct Cases 1939-1950.*

*Number of admitted and dead*

*Number*



*Total number of admitted = 232*

*" " " dead = 74*

missions during any one of these years in Umeå (46 cases during 1950 on a bed-capacity of 151) is compared with those admitted to Örebro — 130 cases during 1948 on 147 beds — and corresponding figures for Gothenburg 179 cases during 1948 on 194 beds it is found that, counted at a percentage, the cardiac infarct occupancy is about three times higher in the latter hospitals as compared with that in Umeå.

### b) *The Rising Frequency of Admission*

Numerically it has thus been established what in the introduction has been said as to the increasing but relatively low frequency of admitted cardiac infarct cases to the Umeå Central Hospital. The figures for sex- and age distribution among the admitted and deceased cases of cardiac infarct are on the whole in accordance with those shown in other statistical reports; this applies also to the rising number of admitted patients. The low figures of admission are, however, divergent. In order to solve this question as to whether special conditions play their part at Umeå I shall try to find out the reason for this increase in the frequency of admission. As this consideration touches upon the morbidity of the total population of the whole receiving area of the Hospital I wish to mention that all the admitted cases with the exception of three, who temporarily visited the area, have been regular residents. These three have been included in the reports except in such cases where special conditions relating to cardiac infarcts of the local population is concerned. — In some of the reports on admissions into the hospital I have grouped together cases from 1949 and 1950 as these years show an obvious increase, and placed the figures obtained from these years in relation to those of preceding years.

If a comparison is made (Table 3) between the total bed-occupancy in the medical clinic and the number of beds occupied by cardiac infarct cases each year for the period between 1939 and 1950, it is found that there is an increase affecting both, but that the annual admission of cardiac infarct cases has increased to a greater extent. The number of beds at disposal has not altered. Counted at a percentage the cardiac infarct cases have increased in relation to the total occupancy especially during the past few years. It was at its lowest during 1941—1942 when, as already mentioned, the number of admissions was relatively small. A great number of the total occupancy was then due to persons called up for military service. The rising number of persons who died from cardiac infarct, particularly during the past few years, corresponds also to an increase of the part they played as regards the percentage of the total number of deaths.

TABLE 3

*Total occupancy and the mortality in the Department of Medicine during each of the years 1939—1950. Number and mortality of cardiac infarcts.*

| Year  | Total number admitted | Number of cardiac infarct cases of these | Total number of deaths | Number of cardiac infarct cases of these |
|-------|-----------------------|------------------------------------------|------------------------|------------------------------------------|
| 1939  | 2,188                 | 9 = 0,4 %                                | 88                     | 2 = 2,3 %                                |
| 1940  | 2,089                 | 11 = 0,5 %                               | 99                     | 2 = 2,0 %                                |
| 1941  | 2,237                 | 4 = 0,2 %                                | 99                     | 1 = 1,0 %                                |
| 1942  | 2,265                 | 6 = 0,3 %                                | 80                     | 4 = 5,0 %                                |
| 1943  | 2,522                 | 16 = 0,6 %                               | 74                     | 3 = 4,1 %                                |
| 1944  | 2,709                 | 18 = 0,7 %                               | 109                    | 5 = 4,6 %                                |
| 1945  | 2,672                 | 15 = 0,6 %                               | 90                     | 6 = 6,7 %                                |
| 1946  | 2,863                 | 15 = 0,5 %                               | 103                    | 7 = 6,8 %                                |
| 1947  | 3,016                 | 32 = 1,1 %                               | 88                     | 7 = 8,0 %                                |
| 1948  | 3,042                 | 22 = 0,7 %                               | 108                    | 7 = 6,5 %                                |
| 1949  | 3,231                 | 38 = 1,2 %                               | 107                    | 13 = 12,1 %                              |
| 1950  | 3,160                 | 46 = 1,5 %                               | 103                    | 17 = 16,5 %                              |
| Total | 31,994                | 232 = 0,7 %                              | 1,148                  | 74 = 6,4 %                               |

Table 4 shows that the number of residents within the receiving area of the Hospital increased during the period 1939—1950 by 10,193 an increase of  $7.5 \pm 0.07$  %. From available statistics it is known that there has been a steady increase during these years, mainly owing to an increased birth-rate. From the Table it is evident that the number of admissions into the medical clinic, amounting to  $44.4 \pm 1.1$  %, is considerably higher taken at a percentage. The increase in the number of residents has certainly played its part in the greater number of admitted patients, but it has not been so great that it furnishes a solution to the marked number of new cases admitted. One has to count with other circumstances influencing this, not the least reason being a desire of the population for social and hospital benefits offered them at the hospital. Here the increasing number of old people among the population has definitely played a great part. If we study the age distribution of all patients admitted into the medical clinic, as seen from the Table, it is evident that the tendency here is the same as in other medical clinics (Meulengracht 1950), namely an increased number of old people admitted. The increase in number of patients ad-



TABLE 4

*The size of the population within the receiving area 1939 and 1950, and the number of admissions into the Department of Medicine during these years, in total figures and in different age groups. Percental distribution of the admissions in age groups.*

| Size of population  | Admitted patients in the Department of Medicine |       |                         |        |       |        |       |        |       |       |      |       |  |
|---------------------|-------------------------------------------------|-------|-------------------------|--------|-------|--------|-------|--------|-------|-------|------|-------|--|
|                     | Year                                            | Total | in different age groups |        |       |        |       |        |       |       |      |       |  |
|                     |                                                 |       | < 50                    |        | 50-59 |        | 60-69 |        | 70-79 |       | ≥ 80 |       |  |
| 1/1 1939<br>135.116 | 1939                                            | 2.188 | 1.540                   | 70,4 % | 327   | 14,9 % | 241   | 11 %   | 73    | 3,3 % | 7    | 0,3 % |  |
| 1/1 1951<br>145.309 | 1950                                            | 3.168 | 1.720                   | 54,4 % | 701   | 22,2 % | 472   | 14,9 % | 247   | 7,8 % | 20   | 0,6 % |  |

mitted is mainly due to admission of people belonging to the older age groups. Counted at a percentage the admission of sick people under the age of 50 has decreased while it has, on the whole, increased for older persons.

### *The Increase in Age*

The view of Master (1947) has already been mentioned that the increased tendency of cardiac infarct among the American population is partly due to an increased number of old people. It seems reasonable that such should also be the case here and that the greater number of old folk among the population within the receiving area of the hospital should give rise to not only an increased frequency of infarcts but also to an increased frequency of admission into the hospital of cardiac infarct cases.

From Table 5. it is clear that during the period of 1949—1950 there was a relatively greater number of old people admitted than earlier. During these years 57 cases of infarct, 60 years of age and above, making up  $67.9 \pm 5.1$  % of all cases admitted for this disease during these years. During the previous years 78 persons belonging to this age group were admitted, making up  $52.7 \pm 4.1$  % of all admitted cases of infarct during these years. The mortality among this material was for the older people  $40.7 \pm 4.2$  % while for the

TABLE 5

*Number of admitted cases of cardiac infarct, number of deaths in the age group 59 and below, and 60 and above during the periods 1939—1948 and 1949—1950. Percental distribution of patients in age groups and mortality percentage.*

| Age    | 1939—1948          |      |                  |         | 1949—1950          |      |                  |         | Total number of |        |         |
|--------|--------------------|------|------------------|---------|--------------------|------|------------------|---------|-----------------|--------|---------|
|        | Number of admitted | %    | Number of deaths | mort. % | Number of admitted | %    | Number of deaths | mort. % | admitted        | deaths | mort. % |
| 59 yrs | 70                 | 47,3 | 11               | 15,7    | 27                 | 32,1 | 8                | 29,6    | 97              | 19     | 19,6    |
| 60 yrs | 78                 | 52,7 | 33               | 42,3    | 57                 | 67,9 | 22               | 38,6    | 135             | 55     | 40,7    |
| Total  | 148                |      | 44               | 29,7    | 84                 |      | 30               | 35,7    | 232             | 74     | 31,9    |

younger  $19.6 \pm 4.0$  %. It was almost the same among the old people of both year groups, but among the younger ones during 1949—1950 it was higher than during previous years ( $29.6 \pm 8.8$  % as against  $15.7 \pm 4.3$  %). The mortality for all admitted during 1949—1950 was  $35.7 \pm 5.2$  % as against  $29.7 \pm 3.8$  % for the previous years. From this follows that there was an increase of admitted old people suffering from infarcts during the latter 2 years as compared with earlier admissions, though this rise is not of significance from a statistical point of view (diff. =  $15.2 \pm 6.5$  %). There was also an increased mortality among those admitted these years, mostly, however, due to an increased mortality among the younger patients. This rise appears to be determined by chance as the difference is not greater than  $13.9 \pm 9.8$  %.

Even if the number of aged people among the population has increased and the increased number of old folk admitted into the hospital has resulted in a rise in the admission of cardiac infarct cases there seems not to be enough reason to explain fully the rising frequency of infarcts and in particular the heavy upward trend evident during the past two years. Neither can the increased mortality due to infarcts during these years be explained.

*Connection between Distance from Patient's home to  
Hospital, and time taken for Admission after Attack,  
Mortality, Frequency of Admission*

If one is to draw conclusions regarding the conditions of the population, one is limited to a certain degree to the information received from and about the infarct patients admitted to the Umeå Central Hospital. Certain prevailing factors must, however, be taken into consideration. Such factors as the long distances to the hospital from a vast receiving area, difficulties in getting transport, distance to travel to nearest doctor, and the appreciation of the seriousness of the symptoms as visualized by both doctor and the sick — all are factors to be reckoned with. They all seem to play a part in considering the frequency of admission, and time for admission of the patient. This again is of importance in forming a picture of the course the disease has taken in the admitted patients. Many a seriously ill patient stays at home in the early stages and only arrives at the hospital when the most acute symptoms are over. A long and tedious transport tends to affect the condition of the patient badly. All this is to be considered in judging the figures of mortality among the admitted ones and particularly in cases of early-mortality. In this group of early-mortality I include those ending in death within 3 days after being taken ill.

The reports on mortality from acute cardiac infarct vary a good deal. According to Master (1947) it would most likely be less than 20 % covering a material of a whole population, and for the first attack less than 10 %. The hospital statistics which usually cover the more serious cases of the type we are concerned with here, show a mortality of about 30—50 %, but even higher figures have been mentioned. The mortality is highest during the first days and the first 3 days are particularly critical. Ejrup and Nylin (1943) and Brahme and Ahlberg (1947) report a 50 % mortality during this period of their hospital cases. After the first week the mortality decreases considerably. Certain observations point to a slightly lower mortality among hospital cases during the first 24 hours but this seems to be due to some serious cases not seeking hospital treatment.

Several factors are of importance for the prognosis of acute car-

TABLE 6 A

*Death after number of days, and the distance from patient's home to the Hospital.*

| Death after days | Distance from patient's home to the Hospital |          |           |            |           | Number of deaths |
|------------------|----------------------------------------------|----------|-----------|------------|-----------|------------------|
|                  | Umeå                                         | < 30 Km. | 40-60 Km. | 70-140 Km. | > 150 Km. |                  |
| 1                | —                                            | —        | —         | —          | —         | —                |
| 2                | 3                                            | 1        | —         | —          | —         | 4                |
| 3                | 1                                            | 4        | —         | 1          | —         | 6                |
| 4—7              | 5                                            | 5        | 1         | 2          | —         | 13               |
| 8—14             | 5                                            | 4        | —         | 1          | —         | 10               |
| 15—21            | 3                                            | 7        | 4         | 2          | —         | 16               |
| 22—28            | 1                                            | 3        | 1         | 4          | —         | 9                |
| > 28             | 7                                            | 2        | 2         | 2          | —         | 13               |
| Uncertain*       | 2                                            | —        | —         | 1          | —         | 3                |
| Total            | 27                                           | 26       | 8         | 13         | —         | 74               |

\*) after 7th day.

TABLE 6 B

*Early and later cases of death in the age group 40—59 years and 60 years and above.*

| Death after days | A g e       |            | Total |
|------------------|-------------|------------|-------|
|                  | 40-59 years | > 60 years |       |
| 1—3              | 3           | 7          | 10    |
| > 4              | 16          | 48         | 64    |
| Total            | 19          | 55         | 74    |

TABLE 6 C

*Early and later cases of death in the age groups 40—59 years and 60 years and above, with sex distribution.*

| Death<br>after<br>days | A g e       |       |            |       | Total |       |
|------------------------|-------------|-------|------------|-------|-------|-------|
|                        | 40-59 years |       | ≥ 60 years |       |       |       |
|                        | Men         | Women | Men        | Women | Men   | Women |
| 1—3                    | 2           | 1     | 5          | 2     | 7     | 3     |
| ≥ 4                    | 14          | 2     | 29         | 19    | 43    | 21    |
| Total                  | 16          | 3     | 34         | 21    | 50    | 24    |



TABLE 6 D

*Day of admission and distance from patient's home to the Hospital re shock cases. (Helander's Group 1.)*

| Admission<br>in days<br>after<br>attack | Distance from patient's home to the Hospital |        |           |        | Total (group 1) |        |
|-----------------------------------------|----------------------------------------------|--------|-----------|--------|-----------------|--------|
|                                         | Umeå—30 Km.                                  |        | > 30 Km.  |        | Surviving       | Deaths |
|                                         | Surviving                                    | Deaths | Surviving | Deaths |                 |        |
| 1—3                                     | —                                            | 11     | —         | 4      | —               | 15     |
| ≥ 4                                     | 3                                            | 1      | 1         | 2      | 4               | 3      |
| Total                                   | 3                                            | 12     | 1         | 6      | 4               | 18     |

diac infarct on the one hand quoad vitam, on the other the question of sudden death or later on. Eckerström (1951) found that the mortality was 68 % during the first 4 weeks among patients above 65 years of age and 45.2 % among younger patients, it was also higher among women than for men in both age groups. Yater et al. (1951) maintain, however, that among men-patients sudden and early deaths are more common in younger men. Coronary disease would then be more fatal in younger men, the tolerance increasing as the years go by. Compare this with A. Jervell's (1935) report on the most severe symptoms in those who were earlier free of symptoms.

The clinically registrable sequence of symptoms such as fever, leucocytosis, increased ESR and so on do not seem to give a clear picture for judging the immediate prognosis. I have abstained from giving a description of these symptoms as they do not differ here in comparison with other material. This is also true in considering the more or less severe consequences which are related to the localization and extent of the infarct and the previous condition of the heart, conditions which by themselves may have prognostic value and about which electrocardiographic investigations to a certain extent may be helpful.

On the other hand it seems to me to be of importance to describe the presence of shock and fall in blood pressure to which the local conditions may play a part. Several writers have pointed out these as signs of poor prognosis in case of acute cardiac infarct. Helander (1950) divided his material, 193 cases, into 3 groups according to

general symptoms and fall in blood pressure. In the more severe cases (Group I) with shock and severe drop in blood pressure the mortality was 57 %, most of the fatal cases occurring during the first 72 hours after being taken ill. Among the medium cases (Group II) 22.4 % ended in death, and in (Group III), mild cases, there was no death. Wällgren (1950) has in his collection of 170 infarct cases, using the same classification as Helander advocates, obtained on the whole the same figures. The mortality in Group I was here 62.5 %.

Table 6 a. shows that among the 74 cases admitted to Umeå Central Hospital ending in death not one took place during the first 24 hours after being taken ill and only 10 cases died during the first 3 days. It is, however, evident that most of them, 53 cases, were admitted from Umeå or from places within the nearest 30-kilometer region. Out of the ten cases which died during the first 3 days after being taken ill nine had been received from this region. Among the 21 cases received from places farther away there was only one case of death during these first 3 days.

Table 6 b. shows in addition that the relatively small number of early-death cases concerned both the older and younger age groups at an about equal degree. Out of 19 dead belonging to the age group 40—59 three died during the first 3 days after being taken ill, corresponding to  $15.8 \pm 8.4$  %. Out of the older age group with 55 dead, 7 died corresponding to  $12.7 \pm 4.5$  % during the first 3 days. Those 7 cases, age 60 and above, made up  $70.0 \pm 14.5$  % of all the early-deaths, but it came to a similar figure, counted at percentage, of  $75.0 \pm 5.4$  % for the 48 patients of the same age group who died later.

Reviewing the sex distribution of the fatal cases (Table 6 c.) it is noticed that 7 of the 50 men and 3 of the 24 women died during the first 3 days, i. e.  $14.0 \pm 4.9$  % early-deaths among the men and  $12.5 \pm 6.8$  % among the women. Among the 34 men, age 60 and above, 5 ( $14.7 \pm 6.1$  %) were early-deaths and among the 16 younger men only 2 ( $12.5 \pm 8.3$  %). Of the women there were only 3 in the age group 40—49 of whom one died within the first 3 days. Of the 21 older women 2 were early-deaths. Thus with 19 cases there appears to be a clear preponderance among the dead women of the

older age group and of those who died later than 3 days after being taken ill. Statistically computing this the percentage of older and later deceased women works out at  $79.2 \pm 8.3 \%$  and for the men the corresponding figure is  $58.0 \pm 7.0 \%$ , hence the difference has not proved guaranteed (diff. =  $21.2 \pm 10.9 \%$ ).

If the admitted cases are divided according to Helander's principle it is found that to Group I, the worst cases with shock symptoms, are assigned 22 cases only of which 18 ( $81.8 \pm 8.2 \%$ ) died, to Group II 198 of which number 56 ( $28.2 \pm 3.2 \%$ ) died, and to Group III, the mildest cases, 12 patients of whom none died. The 22 cases belonging to Group I, being of particular interest just now, are collected in Table 6 d. This Table shows that 15 patients were admitted during the first 3 days after being taken ill and that all of them died. Out of this number 11 were residents within an area not farther than 30 Km. from the Hospital, 6 of them came from the city of Umeå. Only 4 came from places farther than 30 Km. distance. Of the 18 shock-cases which ended fatally 5 had travelled about 30 Km. to reach the hospital, 1 travelled 60 Km. and 5 had a journey of from 70 to 140 Km. Nine of these patients made the trip during the first 3 days after being taken ill. The 4 shock-cases which survived were admitted later than 3 days after attack. Of these 3 came from the Umeå region and one still farther away. It ought to be mentioned that of 12 cases belonging to Group III eleven were admitted after the 3 day period was up, and nine of them as late as after a fortnight. Only 5 came from the Umeå region, the other seven from places situated 70 Km. or more from the hospital.

Thus it has not been evident from this material that the usual early-mortality occurred with the highest number of deaths the first 3 days being after taken ill, nor is the declining number of deaths evident after the first week is up. Neither is there any overwhelming early-mortality for the different age groups, nor for the women in proportion to the men. A survey of the material according to the principle of Helander has in addition showed a relatively low number falling within Group I, shock-cases, but a considerably higher number of deaths among these cases.

In elucidating the cause of these discrepancies of the Umeå ma-

TABLE 7 A

*Day of admission, distance from patient's home to the Hospital,  
number of admitted cases and deaths.*

| Admission<br>in days<br>after<br>attack | Distance from patient's home to the Hospital |        |           |        |           |        |            |        |           |        |       |        |
|-----------------------------------------|----------------------------------------------|--------|-----------|--------|-----------|--------|------------|--------|-----------|--------|-------|--------|
|                                         | Umeå                                         |        | 10-30 Km. |        | 40-60 Km. |        | 70-140 Km. |        | ≥ 150 Km. |        | Total |        |
|                                         | adm.                                         | deaths | adm.      | deaths | adm.      | deaths | adm.       | deaths | adm.      | deaths | adm.  | deaths |
| 1                                       | 26                                           | 7      | 23        | 9      | 2         | 2      | 11         | 2      | —         | —      | 62    | 20     |
| 2                                       | 11                                           | 2      | 13        | 4      | 2         | —      | 3          | 2      | 1         | —      | 30    | 8      |
| 3                                       | 12                                           | 5      | 9         | 3      | 3         | —      | 3          | 1      | 1         | —      | 28    | 9      |
| 4—7                                     | 13                                           | 6      | 20        | 8      | 6         | 1      | 7          | 2      | —         | —      | 46    | 17     |
| 8—14                                    | 6                                            | 3      | 5         | 1      | 4         | 3      | 5          | 1      | 3         | —      | 23    | 8      |
| 15—21                                   | 2                                            | —      | 4         | —      | 2         | —      | 6          | 3      | 3         | —      | 17    | 3      |
| 22—28                                   | 2                                            | 1      | 2         | —      | 1         | 1      | 1          | —      | —         | —      | 6     | 2      |
| > 28                                    | 2                                            | 1      | 3         | 1      | 3         | 1      | 5          | 1      | 2         | —      | 15    | 4      |
| Uncertain*                              | 2                                            | 2      | —         | —      | —         | —      | 2          | 1      | 1         | —      | 5     | 3      |
| Total                                   | 76                                           | 27     | 79        | 26     | 23        | 8      | 43         | 13     | 11        | —      | 232   | 74     |

\*) Attack in all cases at least 8 days before admission.

TABLE 7 B

*Number of cases admitted within 3 days and later after the attack.  
Distance 30 Km. to the Hospital and farther.  
Mortality among those.*

| Admission<br>in days<br>after<br>attack | Distance from patient's home to the Hospital |        |         |          |        |         | Total |        |         |
|-----------------------------------------|----------------------------------------------|--------|---------|----------|--------|---------|-------|--------|---------|
|                                         | Umeå—30 Km.                                  |        |         | > 30 Km. |        |         |       |        |         |
|                                         | adm.                                         | deaths | mort. % | adm.     | deaths | mort. % | adm.  | deaths | mort. % |
| 1—3                                     | 94                                           | 30     | 31,9    | 26       | 7      | 26,9    | 120   | 37     | 30,8    |
| > 3                                     | 61                                           | 23     | 37,7    | 51       | 14     | 27,5    | 112   | 37     | 33,0    |
| Total                                   | 155                                          | 53     | 34,2    | 77       | 21     | 27,3    | 232   | 74     | 31,9    |

terial of infarct cases, diverting from the typical early-mortality, it does not seem justifiable to place the emphasis on the disease as such. On the other hand it appears of importance to investigate to what extent the time of admission has played its role and also the distance from place of residence to hospital, particularly after what has been evinced from Tables 6 a. and 6 d. It may be added that the trying transport has adversely affected some of the shock-cases, arriving at



the hospital in a poor condition, and that this has contributed to the high mortality among them.

Table 7 a. shows the correlation between infarct cases admitted and the number of deaths among them in relation to the distance from patient's home to the hospital and the time after falling ill and admission. In Table 7 b. all the cases are brought together which came from Umeå and the region within the 30 Km. limit, and those which came from places farther situated, the classification also being based on whether the patient was admitted during the first 72 hours after being taken ill or later. The greatest number of admissions come from the neighbourhood of the hospital as was to be expected, i. e. from Umeå and places within the 30 Km. limit. This number of admissions is considerably larger than one would expect from the distribution of the population within the receiving area of the Hospital which shows that about one-third of the population lives within the 30 Km. area and about one-tenth reside in Umeå. The same figures apply to the number of deaths.

Out of 232 admitted cases 155 ( $66.8 \pm 3.1 \%$ ) came from this region, and of the 74 dead 53 came from the same area ( $71.6 \pm 5.2 \%$ ) (Table 7 b.). It may also be noticed (Table 7 a.) that from the city of Umeå such a great number as 76 were admitted ( $32.8 \pm 3.1 \%$  of the total and  $49.0 \pm 4.0 \%$  of the 155 from the Umeå region) with 27 dead ( $36.5 \pm 5.6 \%$  of total and  $50.9 \pm 6.9 \%$  of the 53 dead from the Umeå region). Table 7 b. also shows that out of the total of 232 admissions about half were admitted during the first 3 days after the attack, i. e. 120 patients ( $51.7 \pm 3.3 \%$ ). Corresponding figures for the Umeå region are  $60.6 \pm 3.9 \%$  and for the city of Umeå  $64.5 \pm 5.5 \%$ . Of 74 dead 37 had been admitted during the first 3 days, i. e.  $50.0 \pm 5.8 \%$ , and for the Umeå region and the city of Umeå the corresponding figures are  $56.6 \pm 6.8 \%$  and  $51.9 \pm 9.6 \%$  respectively. 94 ( $78.3 \pm 3.8 \%$ ) of the early admitted cases came from the Umeå region. Of these 30 died ( $81.1 \pm 6.4 \%$  of the 37 dead among the early admitted).

Among the 155 who came from the Umeå region these 94 were the greatest number ( $60.6 \pm 3.9 \%$ ) as the 30 dead among them ( $56.6 \pm 6.8 \%$ ) was the highest number of the 53 dead of the same

group. The figures for the city of Umeå were 49 admitted and 14 deaths among those 3 day-cases making a percentage of  $40.8 \pm 4.5 \%$  for admitted among the total of early-admitted ones and  $52.1 \pm 5.2 \%$  among the early-admitted cases from the Umeå region while for the fatal cases of them  $37.8 \pm 8.0 \%$  and  $46.7 \pm 9.1 \%$  respectively. Of the 77 ( $33.2 \pm 3.1 \%$  of the admitted ones) who came from a distance of 40 Km. or more from the hospital there were 21 dead ( $28.4 \pm 5.2 \%$  of total dead). Of those 77 cases residing still farther away 26 cases only were admitted during the first 3 days ( $21.7 \pm 3.8 \%$  of the early-admitted ones and  $33.8 \pm 5.4 \%$  of those from far-off places). Compared with the Umeå region the difference will be  $26.8 \pm 6.7 \%$ , i. e. statistically proved, which would be natural. Of these 26 seven died, corresponding to  $18.9 \pm 6.4 \%$  of the total dead among the early-admitted, and  $33.3 \pm 10.3 \%$  of those who died coming from far-off places.

From Table 6 a. it is evident that the usual higher mortality seen in cases of acute cardiac infarct during the first days after the attack is not noticeable in the admitted patients of this material. Table 7 b. shows on the other hand that the mortality was  $30.8 \pm 4.2 \%$  among those who were admitted during the first 3 days after being taken ill and among those admitted later  $33.0 \pm 4.4 \%$  while the figure for the total material was  $31.9 \pm 3.1 \%$ . There was, however, a slightly higher mortality ( $34.2 \pm 3.8 \%$ ) among the cases from the Umeå region than among those who resided farther away from the hospital ( $27.3 \pm 5.1 \%$ ). Among those admitted within 3 days after the initial attack there was a similar mortality in excess among the patients of the Umeå region, ( $31.9 \pm 4.8 \%$ ) in comparison with that of the others ( $26.9 \pm 8.7 \%$ ). Among the latter admissions this excess of the Umeå region cases was more pronounced with  $37.7 \pm 6.2 \%$  as against  $27.5 \pm 6.3 \%$ . The mortality was relatively high ( $35.5 \pm 5.5 \%$ ) of the cases admitted from the city of Umeå, i. e. from the immediate proximity of the Hospital.

For the 3 days material from Umeå the mortality was  $28.6 \pm 6.5 \%$  but for the latter as high as  $48.1 \pm 9.6 \%$ , the highest figure in all the groups. It ought also to be mentioned that among the 11 cases coming from the far-off places, 150 Km. and more, there was

no mortality. Most of them were admitted late after the attack, only 2 admitted during the first 3 days.

Thus it is apparent from Tables 7 a. and 7 b. that it is mostly serious cases with a poor prognosis which have been admitted from the neighbourhood of the hospital and that these cases generally have arrived earlier than the ones from far-off places.

*Connection between the Rising Frequency of Admission and Early Admission, increased Admission of Patients living near by. The Mortality related herewith.*

It has thus been shown that the distance between the place where the patient was taken ill and the hospital, as well as the time for admission after the attack has influenced both the frequency of admission and the number of fatal cases. In order to obtain an explanation of this increase of admitted and fatal cases which has taken place during the past 2 years especially, I have grouped this material, taking these factors into consideration and propose to deal with them for each year covered by the investigation. Tables 8 a. and 8 b. show that the increase of frequency of admission is most pronounced for those who were admitted during the first 3 days after the attack, and particularly those admitted during the first 24 hours. Of the total number of 120 cases received during the first 3 days 46 cases were admitted during 1949—1950 ( $38.3 \pm 4.4 \%$ ) while out of the 62 patients admitted during the first 24 hours 28 cases ( $45.2 \pm 6.3 \%$ ) belonged to admissions during these past two years. Of the 112 patients who were admitted later than 3 days 38 ( $33.9 \pm 4.5 \%$ ) were received during the past two years. From Table 8 b. it is also evident that the greater mortality during 1949—1950 than during previous years, occurred among those who came in during the first 3 days after the attack. The mortality among these cases for the past two years was  $39.1 \pm 7.2 \%$  as against  $25.7 \pm 5.1 \%$  for earlier years. The somewhat lower mortality among the patients admitted during the first 24 hours is explained by the fact, as mentioned above, that badly acute cases have been admitted on a lesser scale. An increase in number of these

TABLE 8 A

*Day of admission, and number of patients admitted each year  
1939—1950, and the number of deaths among them.*

| Year  | Day of Admission after Attack |        |      |        |      |        |      |        |      |        |       |        |       |        |      |        | Total |        |         |
|-------|-------------------------------|--------|------|--------|------|--------|------|--------|------|--------|-------|--------|-------|--------|------|--------|-------|--------|---------|
|       | 1                             |        | 2    |        | 3    |        | 4-7  |        | 8-14 |        | 15-21 |        | 22-28 |        | > 28 |        |       |        | uncert. |
|       | adm.                          | deaths | adm. | deaths | adm. | deaths | adm. | deaths | adm. | deaths | adm.  | deaths | adm.  | deaths | adm. | deaths | adm.  | deaths |         |
| 1939  | 5                             | 1      | —    | —      | 1    | —      | 3    | 1      | —    | —      | —     | —      | —     | —      | —    | —      | 9     | 2      |         |
| 1940  | 2                             | —      | 2    | 1      | 2    | 1      | 2    | —      | —    | —      | 1     | —      | 1     | —      | 1    | —      | 11    | 2      |         |
| 1941  | 2                             | 1      | —    | —      | 1    | —      | 1    | —      | —    | —      | —     | —      | —     | —      | —    | —      | 4     | 1      |         |
| 1942  | 3                             | 2      | —    | —      | 1    | 1      | 1    | —      | 1    | 1      | —     | —      | —     | —      | —    | —      | 6     | 4      |         |
| 1943  | 2                             | 1      | 4    | 1      | 2    | —      | 3    | 1      | 1    | —      | 1     | —      | —     | 2      | —    | 1      | 16    | 3      |         |
| 1944  | 4                             | 1      | 4    | 1      | 4    | 2      | 2    | —      | 1    | 1      | 2     | —      | —     | 1      | —    | —      | 18    | 5      |         |
| 1945  | 2                             | 1      | 3    | 1      | 1    | —      | 4    | 2      | 3    | —      | —     | 1      | 1     | —      | —    | 1      | 15    | 6      |         |
| 1946  | 4                             | 1      | 1    | —      | 2    | —      | 3    | 3      | 2    | 2      | —     | —      | —     | 3      | 1    | —      | 15    | 7      |         |
| 1947  | 8                             | 1      | 2    | —      | 3    | —      | 10   | 4      | 4    | —      | 2     | 1      | 1     | —      | 2    | 1      | 32    | 7      |         |
| 1948  | 2                             | 1      | 4    | 1      | 3    | —      | 2    | 1      | 6    | 3      | 3     | —      | —     | 2      | 1    | —      | 22    | 7      |         |
| 1949  | 13                            | 5      | 4    | 1      | 3    | 1      | 6    | 1      | 3    | 1      | 4     | 2      | 2     | 1      | 3    | 1      | 38    | 13     |         |
| 1950  | 15                            | 5      | 6    | 2      | 5    | 4      | 9    | 4      | 2    | —      | 4     | —      | 1     | —      | 1    | —      | 46    | 17     |         |
| Total | 62                            | 20     | 30   | 8      | 28   | 9      | 46   | 17     | 23   | 8      | 17    | 3      | 6     | 2      | 15   | 4      | 5     | 232    | 74      |

TABLE 8 B

*Number of admissions from 1st to 3rd days and later after  
the attack during 1939—1948 and 1949—1950.  
The mortality among these.*

| Year      | Day of Admission after Attack |        |      |      |        |      |      |        |      | Total |        |      |
|-----------|-------------------------------|--------|------|------|--------|------|------|--------|------|-------|--------|------|
|           | 1                             |        |      | 1—3  |        |      | > 3  |        |      |       |        |      |
|           | adm.                          | deaths | %    | adm. | deaths | %    | adm. | deaths | %    | adm.  | deaths | %    |
| 1939—1948 | 34                            | 10     | 29,4 | 74   | 19     | 25,7 | 74   | 25     | 33,8 | 148   | 44     | 29,7 |
| 1949—1950 | 28                            | 10     | 35,7 | 46   | 18     | 39,1 | 38   | 12     | 31,6 | 84    | 30     | 35,7 |
| Total     | 62                            | 20     | 32,3 | 120  | 37     | 30,8 | 112  | 37     | 33,0 | 232   | 74     | 31,9 |

cases during the past few years and with a slightly increased mortality has been observed ( $35.7 \pm 9.1$  % as against previous  $29.4 \pm 7.8$  %), though this is statistically not guaranteed.



It has already been shown that the early-admissions mostly came from the immediate neighbourhood of the hospital and that the mortality among them was higher than among those who came from far-off places. From Tables 9 a. and 9 b. it is noticed that it was the admissions from the neighbourhood of the Hospital which gave cause for the higher figures during 1949—1950. Of the 84 cases admitted during 1949—1950  $57 (67.9 \pm 5.1 \%)$  came from the 30 Km. region while of the 148 admitted during the previous 10 years 98 ( $66.2 \pm 3.9 \%$ ) came from the same area. In addition it ought to be mentioned that the admissions from Umeå city showed the relatively greater increase. The admissions from Umeå for the past two years were 34 ( $40.5 \pm 5.4 \%$  of the 84 admitted) as against 42 earlier ( $28.4 \pm 3.7 \%$  of the 148 received during those years). From Table 9 b. it is apparent that the increased mortality, as mentioned already, among patients admitted during the past two years affects both those from the Umeå region (increase from  $32.7 \pm 4.7 \%$  to  $36.8 \pm 6.4 \%$ ) as well as those from far-off places (increase from  $24.0 \pm 6.0 \%$  to  $33.3 \pm 9.1 \%$ ) and that the mortality was greater among the cases, both year groups, coming from the Umeå region. The mortality among those received from Umeå was 1949—1950  $38.2 \pm 8.3 \%$  as against earlier  $33.3 \pm 7.3 \%$ .

It seems to me that the findings mentioned above, shown in the Tables 7 to 9, strongly point to an explanation of the increased frequency of admission of cardiac infarct cases, particularly during the last two years, in the medical department of the Umeå Central Hospital, and also explain the increase in number of deaths from this disease. Earlier I have considered the increased age of the population and the greater number of aged people admitted to be of lesser importance in this matter. I have been able to show that the admission of infarct cases has been greatest from the neighbourhood of the hospital and that it has been greater from this area even considering the density of the population within the receiving area. Those from the neighbourhood of the hospital have as a rule sought admission earlier after being taken ill than those living farther away. The mortality was slightly greater among those who came from nearby places even if they arrived during a later period. The marked increase of admission du-

TABLE 9 A

*The distance from the patient's home to the Hospital, number of admissions each year during 1939—1950.*

*Number of deaths among these cases.*

| Year  | Distance from patient's home to the Hospital |        |      |        |       |        |        |        |           |        | Total |        |
|-------|----------------------------------------------|--------|------|--------|-------|--------|--------|--------|-----------|--------|-------|--------|
|       | Umeå                                         |        | ≤ 30 |        | 40—60 |        | 70—140 |        | ≥ 150 Km. |        |       |        |
|       | adm.                                         | deaths | adm. | deaths | adm.  | deaths | adm.   | deaths | adm.      | deaths | adm.  | deaths |
| 1939  | 1                                            | 1      | 3    | —      | 2     | 1      | 2      | —      | 1         | —      | 9     | 2      |
| 1940  | 2                                            | 1      | 7    | —      | —     | —      | 2      | 1      | —         | —      | 11    | 2      |
| 1941  | 1                                            | —      | 2    | 1      | —     | —      | 1      | —      | —         | —      | 4     | 1      |
| 1942  | 4                                            | 3      | 2    | 1      | —     | —      | —      | —      | —         | —      | 6     | 4      |
| 1943  | 4                                            | 1      | 7    | 2      | 2     | —      | 2      | —      | 1         | —      | 16    | 3      |
| 1944  | 4                                            | 1      | 6    | 2      | 1     | 1      | 5      | 1      | 2         | —      | 18    | 5      |
| 1945  | 5                                            | 3      | 6    | 3      | 1     | —      | 2      | —      | 1         | —      | 15    | 6      |
| 1946  | 4                                            | 1      | 7    | 4      | 3     | 2      | 1      | —      | —         | —      | 15    | 7      |
| 1947  | 10                                           | 1      | 8    | 3      | 7     | 1      | 5      | 2      | 2         | —      | 32    | 7      |
| 1948  | 7                                            | 2      | 8    | 2      | 1     | 1      | 4      | 2      | 2         | —      | 22    | 7      |
| 1949  | 18                                           | 7      | 7    | 2      | 3     | 1      | 10     | 3      | —         | —      | 38    | 13     |
| 1950  | 16                                           | 6      | 16   | 6      | 3     | 1      | 9      | 4      | 2         | —      | 46    | 17     |
| Total | 76                                           | 27     | 79   | 26     | 23    | 8      | 43     | 13     | 11        | —      | 232   | 74     |

TABLE 9 B

*Patients admitted during the periods 1939—1948 and 1949—1950 from Umeå, from Umeå and 30 Km. distance, and from places farther than 30 Km. away. Mortality among these cases.*

| Year      | Distance of patient's home to the Hospital |        |         |             |        |         |          |        |         | Total |        |         |
|-----------|--------------------------------------------|--------|---------|-------------|--------|---------|----------|--------|---------|-------|--------|---------|
|           | Umeå                                       |        |         | Umeå—30 Km. |        |         | > 30 Km. |        |         |       |        |         |
|           | adm.                                       | deaths | mort. % | adm.        | deaths | mort. % | adm.     | deaths | mort. % | adm.  | deaths | mort. % |
| 1939—1948 | 42                                         | 14     | 33,3    | 98          | 32     | 32,7    | 50       | 12     | 24,0    | 148   | 44     | 29,7    |
| 1949—1950 | 34                                         | 13     | 38,2    | 57          | 21     | 36,8    | 27       | 9      | 33,3    | 84    | 30     | 35,7    |
| Total     | 76                                         | 27     | 35,5    | 155         | 53     | 34,2    | 77       | 21     | 27,3    | 232   | 74     | 31,9    |

ring the past two years was most pronounced among the early admissions, among whom the mortality was greater than among those who came in later after the attack; this is also true regarding those living close to the hospital. The admission of patients living farther

away has been in smaller numbers and these patients have most often arrived in the later stages of the disease, when the fatal danger generally is less and when they were in relatively good condition.

An increased knowledge and understanding of the cardiac infarct condition both among doctors and the population and also a general desire for hospital treatment have all contributed to an increased frequency of admission. The increased early admission as well as the increased admission of dangerously ill patients with a resulting rise of the mortality figures among the admitted ones presents a likely connection. Those living close-by, with better facilities for transport and medical advice, have sought admission in relatively greater number than those living far-off; they have come at an earlier stage of the illness and this group has consisted of severely ill patients.

The early-mortality, so typical in cardiac infarct cases of the acute form and especially for certain categories, was not pronounced among these admissions. This also seems to me to be connected with the distance the patients had to travel to the hospital, their transport facilities and the time of arrival after the attack. In a very early stage of the disease severely ill patients have arrived in relatively small numbers which explains why there has been no deaths during the first 24 hours after being taken ill. Most of the early-deaths came from the neighbourhood of the hospital. The long distance and transport difficulties seem to have contributed to the relatively low number of admission of grave shock cases.

The reason for the increased number of cardiac infarct cases under treatment in the hospital should thus only be due partly to an increased morbidity of this disease among the population. The social conditions dealt with above seem to be the real cause and particularly of the marked rise during the past few years. Even the mortality observed during the recent years can thus be explained. An increased frequency of infarcts in a hospital cannot be taken as a substantiation of an increased morbidity among the population without careful penetration of certain conditions which by themselves seem to have little to do with the disease.

### *c) The low Frequency of Admission*

In order to solve the question of morbidity frequency in cardiac infarct among the population it is apparent that new ways and means will have to be tried. I have already mentioned the comparatively small number of cardiac infarct cases admitted to the Umeå Central Hospital. A closer examination of the cause hereof would probably assist in solving the question.

#### *Relatively smaller number of Admissions from the Country Districts than from Towns and Municipalities*

From Table 10 it is evident that there is a marked difference in the frequency of admission from the country districts and from the built-up areas when taking the size of the population into consideration. The question then arises: does this depend on different conditions of morbidity or are there other causes as well?

Table 10 shows that of 228 admissions of cardiac infarct from the whole receiving area 115 ( $50.4 \pm 3.3$  %) came from the country districts and 113 ( $49.6 \pm 3.3$  %) from the towns and municipalities. In spite of the greater number of inhabitants living out in the countryside ( $78.7 \pm 0.11$  %) there has been about the same number of infarct cases from there as from the towns and municipalities. Taking all admissions from the entire receiving area they make up  $0.16 \pm 0.01$  % of the total population; those admitted from towns and municipalities  $0.37 \pm 0.03$  % and those from the countryside  $0.10 \pm 0.01$  % of the population there. From the Umeå region, which includes the city of Umeå and neighbouring parishes as well as the municipalities of Holmsund and Vännäs, situated 10 Km. and 30 Km. respectively from Umeå, most people come making up  $68.4 \pm 3.1$  % of total admissions. The Umeå region is inhabited by  $37.3 \pm 0.13$  % of the population. The admissions made up  $0.29 \pm 0.02$  % of the population, while the admissions from Umeå city amounted to  $0.43 \pm 0.05$  %, from Holmsund  $0.51 \pm 0.10$  %, from Vännäs municipality



TABLE 10

*Population of Towns, Municipalities and Country Districts in  
Receiving Area; Percentage Distribution of Population.*

*Number admitted from different places; Percentage distribution of  
admitted cases from different areas and of total number admitted.*

*Mortality rate of those admitted from receiving area; Percentage  
distribution of deaths from different areas, and total mortality rate.*

*Average Age of Admitted from Receiving Area.*

| Place of<br>residence                   | Inhabitants<br>1/1 1951 |             | Admitted<br>cases: |                     |                         | Deaths |                         |                          | Average<br>age of<br>patients |
|-----------------------------------------|-------------------------|-------------|--------------------|---------------------|-------------------------|--------|-------------------------|--------------------------|-------------------------------|
|                                         | Number                  | % of number | Number             | % of number<br>inh. | % of number<br>admitted | Number | % of number<br>admitted | % of number<br>of deaths |                               |
| Towns: Umeå . . . . .                   | 17,113                  | 11,8        | 73                 | 0,43                | 32,0                    | 26     | 35,6                    | 35,6                     | 62                            |
| Lycksele . . . . .                      | 3,413                   | 2,3         | 7                  | 0,21                | 3,1                     | 3      | 42,9                    | 4,1                      | 63                            |
| Municip: Holmsund . . . . .             | 5,294                   | 3,6         | 27                 | 0,51                | 11,8                    | 11     | 40,7                    | 15,1                     | 60                            |
| Vännäs . . . . .                        | 3,075                   | 2,1         | 6                  | 0,20                | 2,6                     | 2      | 33,3                    | 2,7                      | 54                            |
| Vilhelmina . . . . .                    | 1,998                   | 1,4         | —                  | —                   | —                       | —      | —                       | —                        | —                             |
| Total                                   | 30,893                  | 21,3        | 113                | 0,37                | 49,6                    | 42     | 37,2                    | 57,5                     | 61                            |
| Country Districts . . . . .             | 114,416                 | 78,7        | 115                | 0,10                | 50,4                    | 31     | 27,0                    | 42,5                     | 62*)                          |
| Total receiving area                    | 145,309                 |             | 228                | 0,16                |                         | 73     | 32,0                    |                          | 61                            |
| Umeå region:**) . . . . .               | 54,156                  | 37,3        | 156                | 0,29                | 68,4                    | 56     | 35,9                    | 76,7                     |                               |
| Umeå regional<br>country dists. . . . . | 28,674                  | 19,7        | 50                 | 0,17                | 21,9                    | 17     | 34,0                    | 23,3                     |                               |
| Stockholm . . . . .                     |                         |             | 3                  |                     |                         | 1      |                         |                          |                               |
| Helsingfors (Finland)                   |                         |             | 1                  |                     |                         | —      |                         |                          |                               |

\*) Larger villages . . . . . 60,7

Country dists. proper . . . . 62,6

\*\*) Umeå town with surrounding parishes and the municipalities of Holmsund  
and Vännäs.

0.20  $\pm$  0.08 % and from the country district of the Umeå region  
0.17  $\pm$  0.02 %. The relatively low frequency of admission from the  
country district around Umeå seems worthy of note when taking into  
consideration the admission from Holmsund which is 3 times greater  
calculated at a percentage. The difference in the frequency of admis-

sion between Holmsund and Umeå country district is  $0.34 \pm 0.10 \%$  which is thus statistically guaranteed. This condition can hardly depend on transport facilities or better social conditions or better possibilities for taking care of sick people in the industrial place of Holmsund as compared with those of the population of the countryside around Umeå. Maybe a greater indolence on the part of the country population plays its part. The admission from the country district around Umeå has, however, statistically guaranteed been greater than from the rest of the countryside ( $0.17 \pm 0.02 \%$  as against  $0.08 \pm 0.01 \%$ ; diff. =  $0.09 \pm 0.02 \%$ ). This would to a certain extent speak for the possibilities of better transport facilities to the hospital situated nearby. The insignificant number of admissions from Lycksele town, the municipalities of Vilhelmina and Vännäs (Table 10) can probably be explained by several reasons, but as far as Lycksele and Vilhelmina are concerned the long distances to the hospital (140 and 250 Km. respectively) seem to be influential.

In addition it may be mentioned that of a total number of 3160 admitted into the medical department during 1950 934 ( $29.6 \pm 0.8 \%$ ) came from towns and municipalities and 2226 ( $70.4 \pm 0.8 \%$ ) from country districts. This is in close conformity with the distribution of the population, even though with a slight excess for the frequency of admission for towns and municipalities as compared with the population. Social conditions seems to be of importance here. Considering the admission of cardiac infarct cases there is, however, so great a difference that additional and specific conditions must have played their part. It may be particularly difficult to transport the badly ill infarct patient from the far off places of the country district resulting in cancelling the trip. Another reason may also be that the morbidity of cardiac infarct is less in the country districts than in the towns and municipalities.

Table 10 shows further this noteworthy fact that the mortality was greater among those who were admitted from towns and municipalities than in those from the country districts ( $37.2 \pm 4.5 \%$  as against  $27.0 \pm 4.1 \%$ ), further that the mortality of the cases from the Umeå region ( $35.9 \pm 3.8 \%$ ) and its countryside ( $34.0 \pm 6.7 \%$ ) was slightly higher than that of the country district as a

whole. This is, however, in accordance with what has been said before (see Table 7 a.) about the greater mortality among the patients admitted from places near the hospital, i. e. from most of the built-up areas. In this connection it may be pointed out that  $76.7 \pm 4.9$  % of the fatal cases came from the Umeå region from where  $68.4 \pm 3.1$  % of the admitted cases also hailed.

As regards the average age of the admitted patients from various places Table 10 shows that no marked difference does exist. It may be noted, however, that among the country cases the average age of the pure farmer population (62.6 years) was slightly higher than that of the population in the larger villages (60.7 years), where there was a sprinkling of tradesmen.

In Table 10 no attention has been paid to the increased number of the population which has taken place within the receiving area of the hospital during the years 1939—1950. The increase has occurred in the following way:

|                              |        |
|------------------------------|--------|
| Births .....                 | 37,786 |
| Deaths .....                 | 16,580 |
| Excess .....                 | 21,206 |
| Moved in and moved out:      |        |
| decrease .....               | 11,013 |
| Increase of population ..... | 10,193 |

An increase of the population with a total of 13,138 persons has taken place in all the municipalities and towns and in some country communities, while a decrease is to be noted with a total of 2,945 persons in most of the country communities. The increase has been greatest in the Umeå region with 7,411 persons. It has already been pointed out that there is no correlation between the increased number of population and the increase in number of admitted cardiac infarct cases. There seems to be no reason to consider that the increase of the population and particularly within the Umeå region is due to a moving in of a large number of old people which would affect the infarct frequency. On the other hand it may be remarked that an addition of 10,000 people with a percentage of admission of cardiac infarct cases of 0.16 % would only correspond to 16 such cases. The

addition observed with regard to the population figure cannot be considered to have influenced greatly the number of admissions.

From figures already mentioned it seems evident that the frequency of admission has been considerably lower in the medical department of Umeå Hospital than has been the case in other hospitals. Judging from the autopsy figures 1948 Wållgren (1950) drew the conclusion that the mortality of cardiac infarcts in Gothenburg was 0.62 per 1000 inhabitants. The mortality among the cardiac infarct cases was estimated at 30 %. According to similar calculations the number of dead from cardiac infarct per annum within the receiving area of the Umeå Hospital should reach a figure of 90 and 300 should have been taken ill. The latter figure must be considered as low. However, not even during a combined period of 10 years have the number of admitted cases in the Central Hospital of Umeå reached such a figure. The low frequency of admission at this hospital might depend on the fact that the cardiac infarct cases only arrive in relatively small numbers or else the morbidity of cardiac infarct here is considerably less than e. g. in Gothenburg.

### *The Morbidity of the Population*

In order to investigate this question further I have sent a questionnaire to the district doctors of the receiving area regarding cases of cardiac infarct within their district, which have not received treatment at the hospital. 20 out of 25 have replied. Though some reports have not come in I consider this of small importance. So many more would not be added that they would substantially alter the final result, which on the other hand, would be of fairly uncertain value. According to the reports, which cover the years 1941—1950 with the majority of cases during the latter 3 years, the diagnoses have been made from clinical findings. ECG-examinations have been made only in a few cases and there is no autopsy examination. Doubtful cases have been eliminated by me.

The reports have been correlated in Tables 11 a. and 11 b. From Table 11 a. it is evident that the number of cases is 48. The mortality percentage is as high as  $70.8 \pm 6.6$  %. This indicates that in most



TABLE 11

*Number of cases of cardiac infarct belonging to the receiving area, treated in and outside the Hospital, and the number of deaths.*

a.

|                                             | Patients | Deaths      |
|---------------------------------------------|----------|-------------|
| Reported by District Medical Officers ..... | 48       | 34 (70,8 %) |
| Admitted to Hosp.: Dept. of Med. ....       | 228      | 73 (32,0 %) |
| Other depts. ....                           | 9        | 9           |
| Total                                       | 285      | 116         |

b.

| Day of death after attack of reported cases |    |   |   |     |
|---------------------------------------------|----|---|---|-----|
| Day .....                                   | 1  | 2 | 3 | > 3 |
| Number of cases ..                          | 14 | 7 | 2 | 11  |

cases there must have been severely ill patients who sought the advice of doctors. The majority died during the first 3 days and most of them during the first 24 hours (Table 11 b.). It is apparently among this clientele that the early-mortality within the receiving area is to be found and which has occurred relatively sparingly in the hospital. The great number of these cases have been so ill that they have not been considered fit to stand the transport to the hospital, and because of this they have received treatment at home or in the nearest cottage hospital.

As a matter of course there have been diagnostic difficulties for the district doctors, e. g. lack of ECG-apparatus and no verification by autopsy. Most likely several cases of sudden death as mentioned in the reports occurred from cardiac infarct, but could not be included in the statistics and there are most likely cases of cardiac infarct which survived an attack, cases which have not been reported or for which medical advice has not even been sought. That this may be the case is evident from some recurring cases among the autopsy material of the hospital, to which question I shall return later. Further it may be mentioned that among the reported fatal cases are a few which earlier sought advice at the hospital for heart complaints. It may be

considered plausible that these complaints have been connected with cardiac infarcts which at the time could not be revealed. The definite increase of reported cases during the past few years, has most likely a considerable connection with the fact that the diagnosis of cardiac infarct has come more generally into use.

From Table 11 a. is seen that in addition 9 cases of cardiac infarct have been under treatment in the hospital, above and in addition to those admitted to the department of medicine. All of these 9 cases died and the diagnosis of infarct was only reached at the autopsy.

The figure of 285 known cardiac infarct cases within the receiving area covering the years 1939—1950, including the 116 cases ending in death, could most likely be added to in order to arrive at the true figures of the actual morbidity and mortality. It is evident that the annual figures for the total receiving area of the Umeå Central Hospital with e. g. a known number of 60 cases of infarct and 28 deaths during the year 1950 — the highest within the area definitely known — is considerably lower than what is given in other statistics regarding true and calculated annual figures. In order to reach the same figures which Wällgren has calculated concerning Gothenburg the number of patients would have to be 5 times as large and the number of deaths multiplied by 3.

According to Wällgren the morbidity of infarct among the population in Gothenburg during 1948 is calculated at 0.21 % with a mortality of 0.062 %. In Umeå the number of known cases was during 1950 21 with 11 deaths. The known morbidity here would then be  $0.12 \pm 0.026$  % and the mortality  $0.064 \pm 0.019$  %. Thus the mortality figures in Umeå for 1950 are practically the same as in Gothenburg in 1948, while the morbidity figures are nearly twice as large in the latter city. I have reason to believe that the mortality figures for Umeå conform more to reality than those evolved regarding the frequency of morbidity and that this latter figure is too low. With a 30 % mortality the number of infarct cases ought to have been about 37, i. e. a morbidity figure equal to that of Gothenburg, that is 0.21 %. It seems reasonable that similar figures of frequency ought to be found in the two cities as it concerns a population living more or less under the same conditions. There seems to be little ground

for the supposition that considerable deviation in the frequency figures in the two cities during 1948—1950 would have taken place, and that that should be an objection to a comparison.

In spite of the frequency figures being obtained mainly from the hospital statistics they are on the whole so much lower for Umeå receiving area that I do not hesitate to draw the conclusion that both the morbidity and mortality figures of infarcts here are definitely lower than corresponding figures for Gothenburg. This would concern particularly the country districts of Västerbotten, even if the social conditions might lead to a certain number of infarct cases occurring undiagnosed and remaining unknown. Corresponding figures for Örebro speak also of a higher frequency of infarcts within this receiving area. Comparing it with Norrköping there seems to be difficulty in obtaining a comparison. But it ought to be noted that during 1946 29 cases of infarct were admitted to the Norrköping Hospital while Umeå Central Hospital with a 50 % higher bed capacity had only 15 cases.

We know from earlier investigations of the then relatively lower frequency of arteriosclerosis among the Umeå material. It appears to me that this ought to result in a relatively smaller number of cardiac infarcts. Lundquist has collected the autopsy material from Umeå Hospital 1941—1951\*). From this investigation was evidenced that there is a certain increase of the frequency of arteriosclerosis among the post-mortem cases. A definite agreement was obtained between this increase in frequency and the rising average age of the clientele.

According to Lundquist the increasing average age should be the reason for the rise in arteriosclerosis. The rise in number of cardiac infarct cases among the autopsy material seen during these years has also occurred along a parallel line with the rise in average age of the arteriosclerosis cases. In the clinical material, presented by me, the increase of the number of admitted cases of cardiac infarct shows a certain relationship to the increased average age among these and among the population as a whole. There is, however, an increase of

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\*) Report of this given at the meeting of the Swedish Society for Geriatrics 31/10 1952.

average age of the population in other parts of the country. Thus, if in spite of the rising average age the frequency of infarct at this Hospital is comparatively low, I propose to seek the explanation hereof in the fact that the morbidity frequency of this disease is low, and that this results in a relatively low frequency and intensity of arteriosclerosis among the population of this receiving area.

The low number of deaths from cardiac infarct may be in relationship to the low morbidity frequency among the population. Whether a lower intensity of the arteriosclerosis also affects the acute prognosis of cardiac infarct leading to a smaller number ending fatally is a question of doubt. The mortality figures among the admitted patients do not give cause for such a conclusion concerning this clientele. It is true that the number of grave shock cases among the admitted was relatively low. It was only 9 % in Umeå while Helander had 29 % and Wållgren 19 %. This cannot be taken as evidence of a more benign form of the acute type among the Umeå cases remembering what was revealed in the reports from the district medical officers that a fair number of seriously ill patients never came under hospital treatment.

### *Sex, Occupation and Place of Residence*

Earlier in this work I have mentioned certain reasons for the relatively low morbidity of cardiac infarct disease within the receiving area of the Umeå Hospital and that this should principally depend on the low frequency of infarct in the country districts. The question then arises whether a significant difference in the mode of living exists between country districts and towns and municipalities, and whether the question of sex and occupation also play their part. A review of the infarct material arranged according to this classification ought to reveal certain findings of value. Accordingly I have classified the material with regard to sex, occupation and place of living (Table 12).

Björck and Blomqvist (1949) found in their statistical investigation on the mortality of cardio-vascular diseases, embracing the whole of Sweden, that arteriosclerosis topped the list, and that there was



TABLE 12

*The admitted patients according to occupation, place of residence and sex.*

| Occupation:                                           | Place of residence       |       |                   |       | Number of cases | %    |
|-------------------------------------------------------|--------------------------|-------|-------------------|-------|-----------------|------|
|                                                       | Towns and municipalities |       | Country districts |       |                 |      |
|                                                       | Men                      | Women | Men               | Women |                 |      |
| Farming and ancillary trades                          | 1                        | —     | 58                | 21    | 80              | 35,1 |
| Industry and crafts .....                             | 35                       | 19    | 14                | 4     | 72              | 31,6 |
| Transport .....                                       | 9                        | —     | 3                 | —     | 12              | 5,3  |
| Commerce .....                                        | 20                       | 9     | 4                 | 1     | 34              | 14,9 |
| Gen. administration service and the professions ..... | 16                       | 1     | 6                 | 2     | 25              | 11,0 |
| Household work .....                                  | —                        | 2     | —                 | 1     | 3               | 1,3  |
| Unspecified work .....                                | —                        | 1     | —                 | 1     | 2               | 0,9  |
| Total                                                 | 81                       | 32    | 85                | 30    | 228             |      |

a higher mortality among men than among women from these diseases, also that city dwellers had a considerably higher mortality than those living in the country districts. The excess mortality was particularly marked among the male city dwellers.

From Table 12 it is apparent that the figures of admission of cardiac infarct cases on the whole show the conditions which the above mentioned investigation suggests. We see the great preponderance of cardiac infarct among males which has already been discussed as typical of this disease, but there is also evidence of a greater preponderance of city-municipal dwellers over the country folk. In proportion to the whole number of population there were 4 times as many admissions, including both sexes, from the former groups. On the same basis of calculation it was found that there is a slightly higher frequency of admission of men than of women from towns and municipalities in comparison with the country districts (ratio: 4:3).

It seems noteworthy that the group »farm-work and ancillary trades» contains the greatest number of admissions with men and women together numbering 80 ( $35.1 \pm 3.2\%$ ). Master's report (1947) that cardiac infarct is equally prevalent among all occupations and strata of the population does not apply to this population. We know, however, that over 50 % of the population of the county of Väster-

botten is occupied in farm work and its ancillary trades, 35.1 % as given above is therefore to be considered as relatively low. It is very likely that the social conditions out in the country districts, as already mentioned above, have contributed to the low figure of admission for the farming population, but we have in addition also to reckon with a very likely lower morbidity in cardiac infarct as a cause in the country districts.

As regards male patients, the group belonging to »farm-work and ancillary trades» constitutes the largest but with a relatively low figure of  $35.5 \pm 3.7$  % of the total number of men-patients admitted. Of 59 men belonging to the farming class all except one lived out in the country districts. The lumbermen belong to the groups »farm-work and ancillary trades». It is of interest to point out in this connection that if the food, so very rich in fat which these lumbermen lived on 20—30 years ago and even earlier, has had an adverse influence on their vascular system we ought by this time to know many more of them with cardiac infarcts than we do, even though the damage to the vascular system might be, to a certain extent, regressive. According to Pihl's (1952) investigations regarding the cholesterol content in different foodstuffs the lumbermen's diet of pork, with an addition of butter and milk, must have supplied about 400 mgm cholesterol a day which must be considered a relatively great quantity. It should also be noted that in our infarct material not a single Lapp is included. The Lapps are from ancient times notorious meat-eaters. Though they have during more recent years adopted a more bland diet, meat (cholesterol content according to Pihl 83 mgm per 100 gm moist weight) together with the fat of their reindeer, is still the main constituent of their food. With my knowledge of the health condition of the Lapps (Ekvall 1940) I consider that arteriosclerosis and its sequelae do not play any role of importance among them.

Further I wish to point out with regard to the other occupational groups, a total of 107 men, most of them belonging to the group »industrial and trades», that 80 ( $74.8 \pm 4.2$  %) of these men lived in cities and municipalities and only 27 ( $25.2 \pm 4.2$  %) out in the country districts. These occupations are mostly found in towns and

municipalities. The admissions from such places have also shown a correspondingly higher number.

As regards the women it may be noted that the number of them from »farm work and ancillary trades» made up  $33.9 \pm 6.0$  %, and that the admissions from other occupations (= 41 women) has, like that of the men, been considerably greater from the towns than from the country districts ( $78.0 \pm 6.5$  % and  $22.0 \pm 6.5$  % respectively). In such cases, where the number of child-births have been reported, I have not been able to substantiate that a greater number of births has increased the risk for infarctuous attacks. Besides the number of admitted women from towns and municipalities was on the whole similar to that of those from the country districts (32 as against 30), i. e. a slightly higher representation from the former, in spite of the fact that the women from the country districts have a decidedly higher number of child-births.

Reviewing the sex- and occupational distribution of the infarct material concerned it is clear that similar conditions persist, which has already been mentioned, that there is a lower morbidity in cardiac infarct among the population of the countryside than among that of the towns and municipalities, and this applies to both men and women, but particularly among the farming population. The greatest morbidity seems to be found among the male population of towns and municipalities.

Brahme and Ahlberg (1947) arrived at the conclusion that cardiac infarct affects particularly the population working under psychic strain and stress. Taking the distribution of occupation into consideration, and the fact that the number of city-dwellers predominate in occupations with psychic strain, it seems reasonable to apply this also to the Umeå-material. — There may be reason to mention here that 38 % of the patients suffering from *ulcus pepticum* admitted into the medical dept. of the Umeå Central Hospital (Ekvall 1945) were lumbermen and farmworkers and that according to the distribution of the population the number of admitted peptic ulcer cases from the country districts was about half of that coming from towns and municipalities. These figures show the same tendency as those obtained for the frequency of cardiac infarct in the hospital. From this one

might conclude that there is a common and connecting link as regards the origin of ulcus pepticum and cardiac infarct. Alsted (1942) found that there is a connecting link between the strain and stress of life of the town dwellers and their higher frequency of peptic ulcer as compared with the quieter life of the country folk and their lesser tendency to develop gastric ulcer. Maybe a similar viewpoint can be applied here when discussing cardiac infarct. It must be admitted that other factors as well play their part. Morris, Heady et al. (1953) showed for example that middle aged men, who have a physically active job, are less likely to develop coronary heart disease than men who have a physically inactive occupation. With this point in view it is not unlikely that the progressive decrease of the farming population and an increase within other occupations together with higher urbanity of the population here is going to result in a tendency to increase the number of cardiac infarcts.

#### *d) Causes Contributing to Cardiac Infarct*

I have already touched upon some factors such as sex, age, housing and living conditions and occupation, by which I have tried to demonstrate to what extent and in what manner they may be of importance to this cardiac infarct material. Behind this, however, lies the fact that the cardiac infarct first and foremost has a connection with arteriosclerosis. I pointed out earlier that the development of arteriosclerosis is most likely due to many cooperating factors and I referred to statements by Henschen regarding certain conditions where arteriosclerosis is common and which also appear to me to be of importance in the genesis of cardiac infarct in this material. Of these conditions I shall closer examine the influence which can be traced to nutritional conditions and to the blood pressure and deal with a few other kindred questions.

#### *The Nutrition Condition*

We know from the so-called »Norrland Investigations» that a great part of the population of Västerbotten lived previously on a very low



diet both as to quality and quantity. Odin (1934) points out that cases of obesity were hardly seen here. The improvement in the living standard and food habit which has later taken place, has to the observer, who has followed the development closely, been quite evident. Referring to the statement of Pihl (1952) where he discusses the question of food and particularly the caloric content in its relation to arteriosclerosis and the influence of the same factors on the frequency of cardio-vascular diseases and to other aspects of this question, it is likely that these food conditions also have their influence in dealing with the frequency of infarct among this population.

As an investigation of the nutritional conditions ought to supply information of value I have in Table 13 collected the body weight of all patients admitted into the medical dept. of Umeå Hospital during the years 1939 and 1950 — the weight being taken immediately at the time of admission. These figures must naturally be judged with great caution as they include patients with various diseases. It is striking, however, — and this is in accordance with the higher living standard of the population, mentioned above, that the average weight for all categories, men and women from towns and country districts, was higher in 1950 than in 1939. From this Table it is also evident that the average body weight of the men, for both years, was higher than that of the women — which also is according to the rule. Both years the average body weight of men from towns and municipalities was higher than that of men from the country. 1939 the average body weight for women from towns and municipalities was lower and in 1950 it was higher than that of the women from the country districts. The difference in weight for the two categories of women was, however, slight. In the male groups the difference was only slight in 1939 while more pronounced in 1950. As a result of this comparison it may be said that an increase in weight among the clientele is taking place, and that a relatively higher average weight for men from towns and municipalities was most noticeable in 1950.

To draw any final conclusions from these figures as regards the nutritional condition and its connection with arteriosclerosis among the population does not appear feasible. It may be stated that there is a certain connection between this ratio of body weight and the

TABLE 13

*The average weight of men and women admitted in the Dept. of Medicine 1939 and 1950 from towns and municipalities, and from country districts.*

| Place of residence   | Patients admitted during 1939 |                       |        |                       | Total  |                       |
|----------------------|-------------------------------|-----------------------|--------|-----------------------|--------|-----------------------|
|                      | Men                           |                       | Women  |                       |        |                       |
|                      | Number                        | Average weight in Kg. | Number | Average weight in Kg. | Number | Average weight in Kg. |
| Towns and municip.   | 191                           | 66,8                  | 197    | 59,0                  | 388    | 62,8                  |
| Country Districts .. | 487                           | 66,3                  | 409    | 59,3                  | 896    | 63,1                  |
| Total                | 678                           | 66,4                  | 606    | 59,2                  | 1,284  | 63,0                  |
|                      |                               |                       |        |                       |        |                       |
| Place of residence   | Patients admitted during 1950 |                       |        |                       | Total  |                       |
|                      | Men                           |                       | Women  |                       |        |                       |
|                      | Number                        | Average weight in Kg. | Number | Average weight in Kg. | Number | Average weight in Kg. |
| Towns and municip.   | 281                           | 70,7                  | 270    | 65,2                  | 551    | 68,0                  |
| Country Districts .. | 696                           | 68,3                  | 593    | 64,8                  | 1,289  | 66,7                  |
| Total                | 977                           | 69,0                  | 863    | 64,9                  | 1,840  | 67,0                  |

observations made by Björk and Blomqvist (1949) on the cardiovascular mortality, especially concerning the preponderance of the male population of towns.

If the increased average body weight of patients admitted can be taken as an indicator of a similar weight increase among the population and that this should have a detrimental influence on the behaviour of arteriosclerosis, it seems reasonable that it should also be reflected in an increased frequency of cardiac infarcts, which again has resulted in an increase of admissions of infarcts to this hospital; patients coming particularly from towns and municipalities. That the food question has played a role of importance among the population as regards the frequency of infarct at this hospital cannot be denied considering the increase after the war with special reference to what has been said in this work, and with reference to observations made in other places.

It would certainly have been of interest to make a comparison between nutritional conditions among the population here and that of other parts of the country. Such possibilities are only available for the conscripted soldiers whose height and weight are recorded at the time of being called up. That some primary and constitutional peculiarity should be decisive does not appear from the examination made as to the height and weight of the young men of 20 from the parishes of Umeå Hospital receiving area, who were conscripted as soldiers 1950. The young men from the country districts had an average body weight of 66.21 kg. while those from the towns and municipalities 66.96 kg. The average height of the young men from the country districts was 173.6 cm. while that of the men from towns and municipalities 174.5 cm.

Both height and weight were thus slightly lower for the men from the country districts. From the standard Tables for the whole of Sweden worked out by Broman, Dahlberg and Lichtenstein (1942) it is seen that the young men from the towns and municipalities of this area have a body weight which conforms with that given in the standard Table while the weight of the boys from the country districts is somewhat lower. The height is slightly less than given in the standard, and still more pronounced among the country boys. One would have expected that Rohrer's index for the young men of Västerbotten to be about 1,20. Instead it is 1,26 without any noticeable difference between the two categories. From this it is evident that young men of 20 from this area are relatively short and stocky in comparison to their height. Very likely this depends on their muscular development which again is due to their early taking up of heavy manual labour. Support for this theory is found in the investigations of Brožek and Keys (1953) who maintain that the »over-weight» observed in physically active, middle-aged men compared with the condition of less active men of the same age, is not caused by fat but by »lean» body tissues and particularly the muscles.

Another conclusion which can be drawn from this investigation is, that the higher average weight of men from towns and municipalities can most likely be caused by fat owing to dietetic reasons as well as connected with less strenuous manual work as compared with that of

the country folk. Broman, Dahlberg and Lichtenstein (1942) are, however, of the opinion that the increased body weight and height in a city population as compared with that in a country population depends on a more pronounced mixing of the genera, i. e. on an increased heterozygosis among the town population.

It is generally believed that arteriosclerosis is more common in mesomorphic, pyknic individuals and that they are more often affected by cardiac infarct than the asthenic types. Opinions seem to differ as to obesity in itself predisposing to cardiac infarct. Levine and Brown (1929) found that cardiac infarct is more common in robust persons with some over-weight, and that it is not common among the lean. Wilens communicates that from his autopsy material it seems evident that obesity plays a more important part in developing arteriosclerosis in men than in women, and this was particularly significant regarding coronary sclerosis in men. Sjövall (1952) noticed in a clientele from a department of internal medicine that cardiosclerosis occurred more frequently in the obese than in the lean and those of average weight of both sexes, except in the older women. French and Dock (1944) found that overweight was the most significant factor in 91 % of 80 cases of death in soldiers, age 20—36, caused by un-complicated coronary sclerosis. Garn et al. (1951), however, could not find any greater overweight in men over 40, who developed cardiac infarct, than in healthy contemporaries with the same living standard. Yater et al. (1951) give similar reports but point to a tendency to over-weight in a marked degree in those who died at the age of 50 and above. Bean (1937) found in his postmortem material of 300 cases of cardiac infarct 29.4 % obese, 49.1 % normal and 21.5 % lean types. He maintains that leanness is no guarantee against this malady. Eckerström (1950) accounts for a relatively small number of obese (43 of 242 cases) in his material and there was no increased mortality among them as compared with the rest. Wilens points out, however, that one has to take into account that a poor nutritional condition of the deceased might be caused by a previous and grave morbid state, which has reduced the obesity earlier present.

In order to form an opinion as to what extent the nutritional condition affects the infarct material in this Hospital a comparison has

TABLE 14 A

*Number and percental distribution of admitted cases with obesity, normal nutritional condition and leanness. Percental distribution according to sex. Average age.*

| Nutritional condition | Cases admitted |      |     |      |       |      |             |      |       |
|-----------------------|----------------|------|-----|------|-------|------|-------------|------|-------|
|                       | N u m b e r    |      |     |      |       |      | Average age |      |       |
|                       | Total          | %    | Men | %    | Women | %    | Total       | Men  | Women |
| Obesity ..            | 75             | 32,3 | 49  | 28,8 | 26    | 41,9 | 60,8        | 58,4 | 65,2  |
| Normal ..             | 117            | 50,4 | 91  | 53,5 | 26    | 41,9 | 60,5        | 60,6 | 60,2  |
| Leanness .            | 40             | 17,2 | 30  | 17,6 | 10    | 16,1 | 63,7        | 62,7 | 66,9  |
| Total                 | 232            |      | 170 | 73,3 | 62    | 26,7 | 61,1        | 60,3 | 63,4  |

TABLE 14 B

*Number and percental distribution of cases of obesity, normal nutritional condition and leanness in different age groups.*

| Nutritional condition | A g e      |       |             |       |             |       |             |       |             |       |            |       |
|-----------------------|------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|------------|-------|
|                       | < 40 years |       | 40-49 years |       | 50-59 years |       | 60-69 years |       | 70-79 years |       | > 80 years |       |
|                       | Number     | %     | Number      | %     | Number      | %     | Number      | %     | Number      | %     | Number     | %     |
| Obesity ..            | —          | —     | 8           | 25,8  | 24          | 36,9  | 28          | 33,3  | 15          | 30,0  | —          | —     |
| Normal ..             | 1          | 100,0 | 20          | 64,5  | 32          | 49,2  | 40          | 47,6  | 23          | 46,0  | 1          | 100,0 |
| Leanness .            | —          | —     | 3           | 9,7   | 9           | 13,8  | 16          | 19,0  | 12          | 24,0  | —          | —     |
| Total                 | 1          | 100,0 | 31          | 100,0 | 65          | 100,0 | 84          | 100,0 | 50          | 100,0 | 1          | 100,0 |

been made in Table 14 a. with this as a starting point. The nutritional condition of the patient has been appraised by means of general inspection of the patient as soon as possible after admission, and checking of weight has been done at the first possible moment. It may be mentioned that those who have been classified as obese are really cases of adipositas, and not only cases who are more or less excessive over-weight. Those listed as lean have been definitely so. From Table 14 a. it appears that normal nutritional condition was present in  $50.4 \pm 3.3$  % of the cases while obesity was found in  $32.3 \pm 3.1$  %, and leanness in  $17.2 \pm 2.5$  %. The numerical ratio men: women was for the total material 2.7:1, among the obese 1.9:1, normal



TABLE 14 C

*The nutritional condition of patients with reference to age groups and sex. Percental sex distribution of obese, normal and lean patients in age groups.*

| Sex    | Nutritional condition | A g e      |       |             |       |             |       |             |       |             |       |            |       |
|--------|-----------------------|------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|------------|-------|
|        |                       | < 40 years |       | 40-49 years |       | 50-59 years |       | 60-69 years |       | 70-79 years |       | ≥ 80 years |       |
|        |                       | Number     | %     | Number      | %     | Number      | %     | Number      | %     | Number      | %     | Number     | %     |
| Men .. | Obesity ..            | —          | —     | 8           | 30,8  | 20          | 37,0  | 13          | 24,5  | 8           | 22,9  | —          | —     |
|        | Normal ..             | 1          | 100,0 | 16          | 61,5  | 26          | 48,1  | 28          | 52,8  | 19          | 54,3  | 1          | 100,0 |
|        | Leanness ..           | —          | —     | 2           | 7,7   | 8           | 14,8  | 12          | 22,6  | 8           | 22,9  | —          | —     |
|        | Total                 | 1          | 100,0 | 26          | 100,0 | 54          | 100,0 | 53          | 100,0 | 35          | 100,0 | 1          | 100,0 |
| Women  | Obesity ..            | —          | —     | —           | —     | 4           | 36,4  | 15          | 48,4  | 7           | 46,7  | —          | —     |
|        | Normal ..             | —          | —     | 4           | 80,0  | 6           | 54,5  | 12          | 38,7  | 4           | 26,7  | —          | —     |
|        | Leanness ..           | —          | —     | 1           | 20,0  | 1           | 9,1   | 4           | 12,9  | 4           | 26,7  | —          | —     |
|        | Total                 | —          | —     | 5           | 100,0 | 11          | 100,0 | 31          | 100,0 | 15          | 100,0 | —          | —     |

TABLE 14 D

*The mortality among the admitted obese, normal and lean patients; percental sex distribution among these. Average age of the dead.*

| Nutritional condition | D e a d     |      |     |      |       |      |                     |      |       |
|-----------------------|-------------|------|-----|------|-------|------|---------------------|------|-------|
|                       | N u m b e r |      |     |      |       |      | A v e r a g e a g e |      |       |
|                       | Total       | %    | Men | %    | Women | %    | Total               | Men  | Women |
| Obesity ..            | 28          | 37,3 | 19  | 38,8 | 9     | 34,6 | 63,5                | 60,7 | 69,3  |
| Normal ..             | 31          | 26,5 | 22  | 24,2 | 9     | 34,6 | 65,5                | 66,5 | 63,2  |
| Leanness ..           | 15          | 37,5 | 9   | 30,0 | 6     | 60,0 | 64,9                | 62,1 | 69,1  |
| Total                 | 74          | 31,9 | 50  | 29,4 | 24    | 38,7 | 64,6                | 63,5 | 67,0  |

3.5: 1 and among the lean 3: 1. The number of the obese are in excess of the lean ones both among men and women, but there were relatively more obese among the women than among the men ( $41.9 \pm 6.3 \%$  as against  $28.8 \pm 3.5 \%$ ). On the other hand there was not any difference counted at a percentage to speak of, among the lean ones of either sex.

From this it seems evident that it is more risky for the obese than

for the lean to develop cardiac infarct. Whether this risk is greater among the obese women than among the obese men, which could be supposed from the figures given above, cannot be decided from this comparison as it is well known that obesity in older women is, as a rule, much more common than among men. In Sjövall's hospital material there is an over-weight in 45 % of the women and 24 % of the men. Taking into consideration that we are dealing with a population material of Västerbotten I am of the opinion that the figure 32.3 %, representing the obese patients among the infarct cases in this hospital, is to be counted as high.

By dividing the material according to age and sex (see Table 2) it was seen that the greatest number ( $36.2 \pm 3.2$  %) was found in the age group 60—69. There was a shifting, however, among the sexes, showing that of the men  $31.8 \pm 3.6$  % were in the age group 50—59, and  $31.2 \pm 3.6$  % in the 60—69 group while for the women there was a clear maximum in the seventh decade with  $50.0 \pm 6.4$  %.

Bean (1937) could not find any clear difference in the frequency of lean, obese or normal in the different age groups. Nor is there in this material with any proved certainty. The maximum percental obese persons occurs in the age group 50—59. Counted at a percentage the number of lean persons seems to increase as the age rises (Table 14 b.).

If the material is divided according to sex it becomes evident (Table 14 c.) that among the men the greatest frequency of obese is still to be found in the age group 50—59, while the maximum figure for the obese women was reached in the 60—69 age group, and even in the highest age group the frequency of obese is higher than in the group 50—59. Also among the women the frequency of the lean increases with age, if the youngest age group is excluded which only contains 5 cases. Figs. 2 a—d. show the distribution of age of the men and women with regard to their different nutritional conditions.

In Table 14 d. the mortality figures are given. This Table shows that there is about the same risk of death for the obese and the lean person, in either case about 37 % mortality. From the other figures there seems to be the same difficulty in drawing any conclusion as to the risk of death for the obese and the lean of either sex. The re-

Fig 2a.

Percental distribution of admitted patients  
according to age and sex

60 %

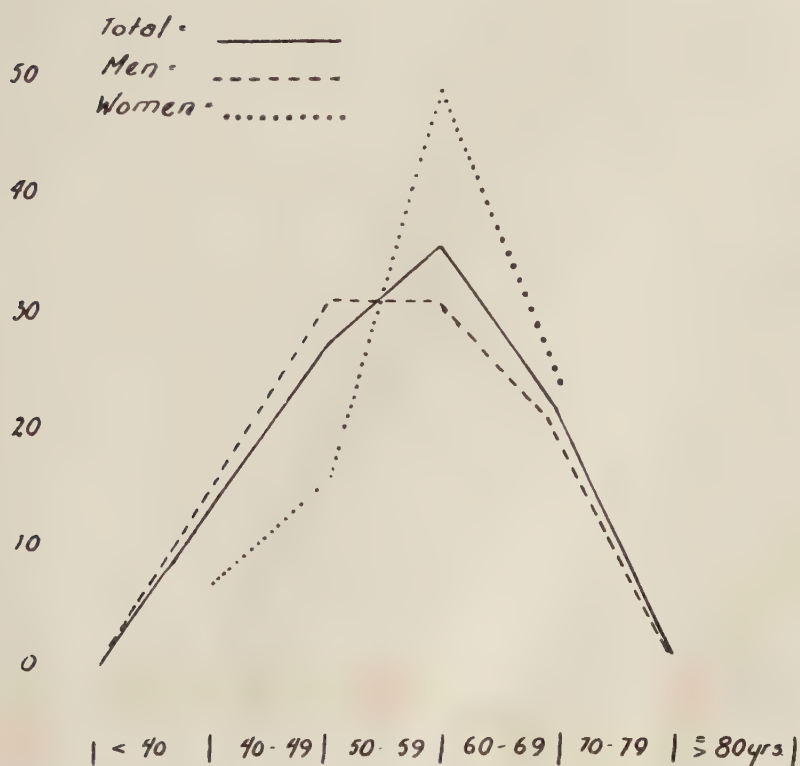


Fig. 2b.

Percent distribution of admitted patients  
according to age and nutritional condition



Fig. 2c.

Percental distribution of admitted men according  
to age and nutritional condition

60%

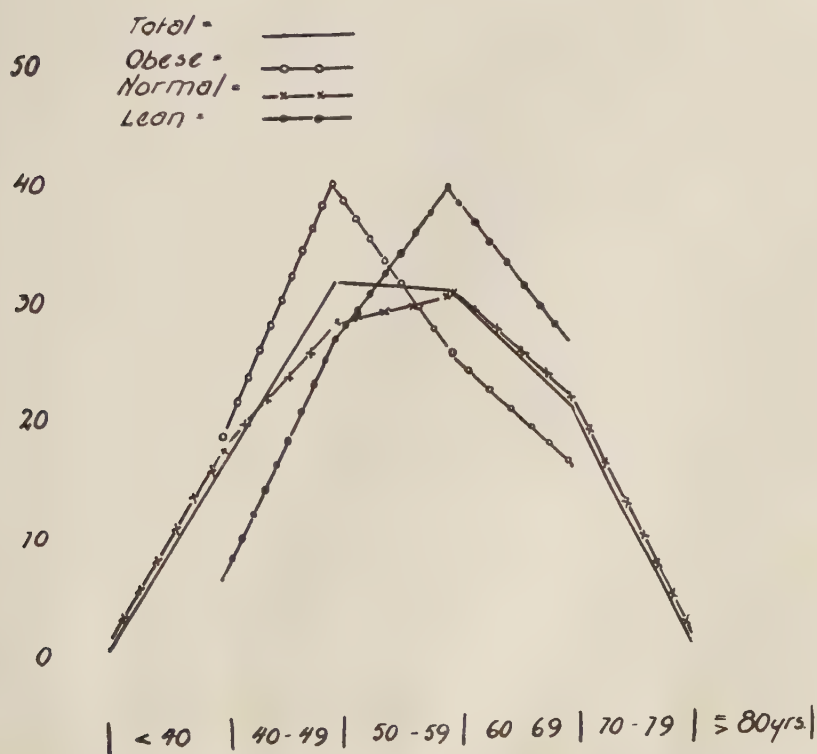




Fig 2d.

Percental distribution of admitted women  
according to age and nutritional condition.

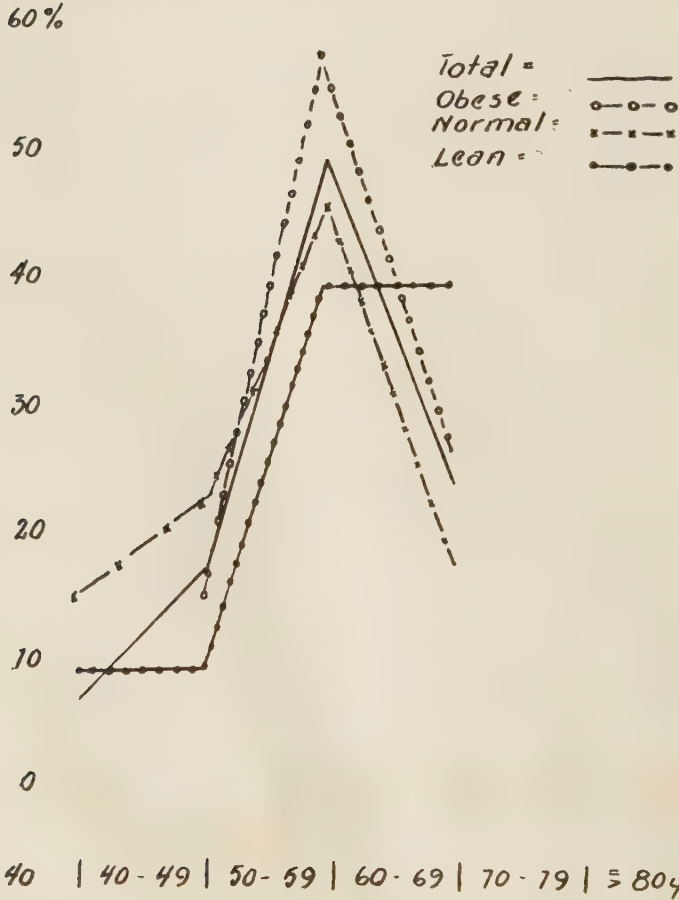


TABLE 15

*Number of cases with obesity and leanness admitted from towns and municipalities, and from country districts; distribution of the cases per 1000 of the population.*

| Place of residence             | Size of the population | Admitted cases |                        |        |                        |
|--------------------------------|------------------------|----------------|------------------------|--------|------------------------|
|                                |                        | obese          |                        | lean   |                        |
|                                |                        | Number         | Per 1000 of population | Number | Per 1000 of population |
| Towns and municipalities ..... | 80,893                 | 35             | 1,13                   | 24     | 0,78                   |
| Country districts ...          | 114,416                | 38             | 0,33                   | 16     | 0,14                   |
| Total                          | 145,309                | 73             |                        | 40     |                        |

markably high figure of 60 % mortality among the lean women — only calculated on 10 cases — shows on closer investigation that this material had in addition other grave and complicated illnesses.

In Tables 14 a. and 14 d. the average age for the different categories is worked out. As was expected the lowest average age was noted among the admitted and the deceased obese men, while it shows a definitely higher average age among obese women than in men. The earlier appearance of arteriosclerosis among men than among women has previously been pointed out. One could thus draw the conclusion that obesity is a contributing factor particularly with regard to the relatively early manifestation of cardiac infarct in men of the obese type.

In order to find an answer to the question whether the nutritional condition contributes to the lower frequency of infarct among the country population, I have in Table 15 divided up the obese and the lean patients according to their place of residence. It was then found that, considering the number of inhabitants, there were more obese and lean ones admitted from towns and municipalities than from the country districts. The number of admissions of obese patients per 1000 inhabitants was 3.4 and of the lean 5.6 times greater from towns and municipalities. It also becomes evident that there was 2.4 times more obese patients from the countryside than lean ones and that the corresponding figure for towns and municipalities was 1.4.

The relatively greater number of admissions from towns and municipalities, which has already been dealt with in the entire material, does repeat itself as regards both the obese and the lean patients. It is, however, evident that the number of admitted lean patients is relatively lower both from the country districts and from the built-up areas. The lean ones from the countryside make up the lowest representation. This points to leanness being advantageous for a lower morbidity of cardiac infarct in both categories of the population, and that the population of the countryside should be best placed in this respect. The proportionately greater number of admissions of obese patients in proportion to lean ones from the country district than as is the case in towns and municipalities, would suggest that, as the conditions are at present, it is more dangerous for a person from the countryside to be obese as regards falling ill from cardiac infarct.

From what has been said earlier with regard to the connection between arteriosclerosis and obesity and between arteriosclerosis and cardiac infarct it seems to me plausible that it must have been the arteriosclerosis which played an important part concerning the greater risk for the obese in this material to be taken ill with cardiac infarct. The relative dominance of the town- and municipal population with regard to both obesity and leanness would — disregarding the greater number of admissions from the built-up areas — speak for a greater frequency of arteriosclerosis among them. The relatively low admission of country folk would have connection not only with general leanness but also with a less pronounced and more seldom occurring arteriosclerosis.

Observation of a decreasing mortality in cardio-vascular diseases during the years of austerity with marked food restrictions has been remarked upon by several authors, and it seems to me to conform with what has just been said about the lesser risk for lean people to fall victims to cardiac infarct. But it also seems plausible from this material that it is the arteriosclerosis which is the decisive factor and that obesity encourages the production of a cardiac infarct in arteriosclerotic patients. I wish to refer to my expressed opinion, mentioned earlier in this work, regarding the functional changes in respect

TABLE 16

*Condition of the blood pressure in admitted patients; Percental distribution and mortality in various stages of blood pressure.*

| Blood Pressure                    | Number of patients | Number of deaths |
|-----------------------------------|--------------------|------------------|
| Hypertonia . . . . ( $\geq 160$ ) | 142 (61 %)         | 38 (27 %)        |
| Normal . . . . . (120—150)        | 67 (29 %)          | 23 (34 %)        |
| Hypotonia . . . . ( $\leq 110$ )  | 3 (1 %)            | 0 —              |
| Uncertain . . . . .               | 20 (9 %)           | 13 (65 %)        |

of the nutritional conditions and their effect on the mortality in arteriosclerosis.

### *Hypertonia, Diabetes Mellitus etc.*

As hypertonia is one of the conditions of importance in connection with arteriosclerosis I have investigated its presence in my material of cardiac infarcts in order to find what role hypertension plays here. Information of varying degree on the connection between hypertension and cardiac infarct is found in several earlier works. This is partly due to the lack of agreement in deciding the limit for hypertonic and normal blood pressure. To this effect I wish to mention that Eckerström (1951) in his infarct material found hypertonia in 30 % while Master et al. (1950) give the figure of 60—70 %. Eckerström considers that there is hypertonia at 160/110 and Master at 150/90 mm. Hg. Hypertension had not in either of these collections resulted in a higher risk of death.

In my material I have calculated hypertension to be present at 160/100 mm. Hg. The recorded blood pressure values have been obtained after stabilization following the occurrence of an infarct. In some cases the values obtained have been based on earlier examinations. A comparison is found in Table 16. Referring to this Table it shows that hypertonia was present in 142 patients ( $61.2 \pm 3.2$  %). Of these 87 were men and 55 women. Among the men hypertonia was present in  $51.2 \pm 3.8$  %, among the women in  $88.7 \pm 4.0$  %. Even

TABLE 17

*Number of cases of Hypertonia admitted from towns and municipalities and country districts; the number of obese and lean ones among them; Distribution of the cases per 1000 of the population.*

| Place of Residence          | Number of Population | Admitted cases of Hypertonia |                        |       |                        |      |                        |
|-----------------------------|----------------------|------------------------------|------------------------|-------|------------------------|------|------------------------|
|                             |                      | Total Number                 | Per 1000 of Population | Obese | Per 1000 of Population | Lean | Per 1000 of Population |
| Towns and Municipalities .. | 30,893               | 73                           | 2.36                   | 22    | 0.71                   | 14   | 0.45                   |
| Country Districts           | 114,416              | 67                           | 0.59                   | 26    | 0.23                   | 6    | 0.05                   |

if we agree with Master (1950) that 55 % of all men have a hypertension of 150/100 or more at the age of 60 and that the percental for women with hypertension at this age is at a considerably higher level, the figure of 88.7 % for the women of this material seems remarkably high. It appears from this material that even if an infarct is formed in case of hypotonia, and even if the infarct is not unusual in normal blood pressure, there is no denying the fact that a certain predisposition for infarct is present in persons suffering from hypertension. The Umeå material does not differ much from what is known from other sources. As in other comparisons hypertension does not seem in this material to have resulted in an increased risk of death. It may be noted that among the 38 deaths from hypertension 20 were men and 18 women, i. e. a mortality among the hypertensive men  $23.0 \pm 4.5$  %, and among the women  $32.7 \pm 6.3$  %. It may be added that the majority among those who were listed as un-defined were most likely cases of hypertension and that the mortality was as high as  $65.0 \pm 10.7$  %.

A scrutiny of the hypertension material according to place of residence (Table 17) shows that the admission of hypertensive infarct cases from towns and municipalities was  $2.36 \pm 0.28$  per 1000, and from the country districts  $0.59 \pm 0.07$  per 1000, which works out 4 times as many from the former areas taken according to the population ratio. The admissions of all the infarct cases were 3.5 times greater per 1000 of the population in towns and municipalities than that of the population from the country. As hypertonia



and arteriosclerosis usually go together this seems to be an explanation of the relatively greater number of admissions of infarct cases from towns and municipalities, and the connection cannot be denied that the relatively lower frequency of admitted hypertensive cases from the country districts has a relation to a lower frequency of arteriosclerosis there. In Table 17 there is also a comparison drawn between obese and lean hypertensive cases with respect to their place of residence. This shows that the number of admissions of obese hypertensive cases per 1000 of the population was 3.1 times greater from towns and municipalities than from the country districts and that the corresponding figure for the lean hypertensive ones was 9. There was 4.6 times a greater number of obese hypertensive persons from the country than lean ones and 1.6 times more obese hypertensive persons from towns and municipalities than lean ones. These figures show somewhat similar proportions which have been mentioned already as regards the admission of obese and lean infarct patients. This is also true in regard to the hypertensive cases of this material — the lean ones from the country districts show the lowest representation. Again we arrive at the same conclusion that the low infarct frequency of the country districts favours leanness among the population there.

Even these conditions indicate that hypertension in itself is not the decisive factor in causing cardiac infarct. The essential point in the explanation of the greater number of admissions of infarct cases from towns and municipalities, even taking the cases of hypertension into consideration is to be found in the greater frequency of arteriosclerosis. Arteriosclerosis has a close connection with both hypertension and obesity. Hypertension and obesity seem to follow each other fairly frequently. Obesity as well as hypertension must be considered as contributing factors to the production of cardiac infarct and a combination with obesity increases this risk.

Diabetes mellitus is another disease which predisposes to arteriosclerosis. In the Umeå material this disease has been found only in 11 cases, of which 6 died. 8 came from towns and municipalities, 3 from the country districts. The average age when the infarct occurred was relatively high, 64 years. — Only one case of myxoedema was

TABLE 18

*The Cholesterol content of the Blood in 31 cases of cardiac infarct, and the presence of arcus senilis corneae.*

| Cholesterol Content of the Blood | Number of Patients | Of these with Arcus senilis |
|----------------------------------|--------------------|-----------------------------|
| > 300 mg %                       | 5                  | 2                           |
| 260—300 » »                      | 3                  | 2                           |
| 210—250 » »                      | 9                  | 4                           |
| 160—200 » »                      | 11                 | 5                           |
| 150—100 » »                      | 3                  | 1                           |
| Total                            | 31                 | 14                          |

noticed, a 49-year old woman who 7 years earlier had had a partial thyroidectomy done.

It has been mentioned earlier that there is a tendency to connect arteriosclerosis and its sequelae with a raised cholesterolaemia. O. Jervell and Eitinger (1950) found in 140 patients suffering from anginoid pains cholesterol values in the blood over 250 mgm % in 35,7 % and over 300 mgm % in 14,4 %. Malmros (1949) communicates that the cholesterol content of the blood was generally at the upper limit in the infarct cases he had examined (normal values supposed to be about 125—200 mgm %). Morrison et al. (1948) found hypercholesterolaemia in 68 % of 200 cases which died from acute coronary disease. There are, however, other investigations, which do not verify hypercholesterolaemia being the rule in cardiac infarcts. Gofman et al. (1950) maintain that the threshold of cholesterol of the blood is unsatisfactory as an indicator of the risk for developing arteriosclerosis and as a prognosis in this disease.

For some time I made investigations of the total cholesterol in the blood in the infarct cases admitted to this hospital. At the same time notice was taken of the presence of arcus senilis corneae in these patients. This disturbance according to Malmros (1949) would be an indication of cholesterosis and thus have a certain connection with arteriosclerosis. In Table 18 is found a comparison of these 31 cases. The estimation of cholesterol was necessarily made at varying times after the infarct had taken place. But in 6 cases two to three

estimations were made during the course of the infarct, from its inception to its cure. The amount of cholesterol then showed certain alterations, but no regularity was evident as regards lower or higher content during the process of healing or in case of worsening. The cholesterol values noted in the Table are the highest obtained in the different cases. The small number of examined cases does not give a decisive answer. The figures obtained do not appear to me to show that a raised blood cholesterol level (more than 200 mgm %), seen in 17 of the 31 cases, made up a rule for this material. Arcus senilis corneae was observed in 14 of the 31 cases; hence no excess for the number with a cardiac infarct combined with arcus senilis over the number of cardiac infarct cases was obtained without this symptom. Nor was arcus senilis more common among the infarct cases with raised blood cholesterol level (8 of 17) than among the other (6 of 14). In addition it ought to be mentioned that the different values of blood cholesterol content and the presence of arcus senilis were about equally spread out in the age groups.

It may further be added that among the cases mentioned in this Table were 2 patients with gallstones with a blood cholesterol value of 210 mgm % in one case and 200 mgm % in the other. No case of diabetes mellitus is included in this Table. Nor was any case of xanthoma seen in the whole of this material.

Further, the following may be mentioned as contributing causes especially affecting the function of the heart: hyperthyreosis in 2 cases, one of which treated with propylthiouracil, valvular disease in 4 cases (2 with stenosis of the aortic valve and 2 with mitral valvular defect), and one case of chronic bronchitis with emphysema.

Only 4 »heavy smokers» (age 44—55) and 4 habitual drunkards (age 44—62) occur in the material. On the whole I have reason to believe that the abuse of liquor and tobacco occurred only very sparingly in this material of cardiac infarct patients.

### *e) The Origin of Cardiac Infarct*

It has previously been mentioned that a cardiac infarct may arise as a result of an acute coronary occlusion, but also without this when

the demand on the myocardial nutrition for some reason or other cannot be satisfactorily met at the time of increased cardiac function. It is this acute ischaemia of the myocardium which gives rise to the symptoms resulting from a state of hypoxaemia (Büchner 1939). At first evidence of angina pectoris appears followed by a myocardial necrosis with different sequelae depending on the severity and duration of the ischaemia as well as on the localization of the necrosis and its extent. Whether the infarct results from an acute arterial occlusion or from insufficient nutrition in some way or other, the clinical symptoms are the same and so are also the myocardial changes.

The acute coronary insufficiency may be of a passing character and does not necessarily lead to irreversible myocardial changes. The more the morbid conditions become evident and give rise to coronary insufficiency, of which the coronary sclerosis is the foremost, the greater will be the tendency of hypoxaemia and its sequelae to develop, and the less will be the tolerance for increased cardiac function under varying conditions. In order to produce an infarct the importance of particular strain on the cardiac function is essential, but this depends not so much on what kind of strain as to how far it affects the heart in its ability to carry on working satisfactorily with available nutrition. The more difficult it is to meet this demand on the nutrition of the heart — remembering that the heart is near the state of anoxaemia — the less powerful need such a releasing cause be.

It may be mentioned here that Master (1947) wanted to differentiate between two acute conditions of cardiac infarcts — those with occlusion and those without. In the first case, occurring mainly without any provocation, it results in the typical trans-mural infarcts. In the latter group, where strain, bleedings, shock etc. are starting causes, the result is in the form of a prognostically favourable subendocardial myo-malacia — apparently similar to Büchner's myocardial foci — and due to coronary insufficiency. In their mildest form they would result in a passing attack of angina pectoris. Master concludes that the infarct with occlusion is the final result of a longstanding arteriosclerosis. In cases of cardiac infarct without occlusion it is also common to find coronary sclerosis but also normal coronary vessels are seen. The infarct would appear in these cases in response to an



increased demand for more blood supply, as for example in cardiac hypertrophy, valvular disease etc. where heavy demand cannot be satisfactorily met. Grüner and Hilden (1951) who have discussed Master's theory, consider it doubtful if this sharp division into two groups is tenable. In their own material they found releasing causes just as often in both groups. They consider that an acute occlusion need not always result in large trans-mural infarcts; it depends on the presence of collaterals.

### *Previous Cardiac Complaints*

In my material has been included, as is mentioned earlier, only cases with clinical and pathologico-anatomical findings typical of the trans-mural cardiac infarcts. It is evident that a relatively large number has never had any cardiac complaints before, at least not of such a serious character as to produce troublesome symptoms of disease. The psychic condition may have been of influence here. Several patients have on account of reasons of age and other causes found it difficult to give a satisfactory account of themselves. A diminished activity with less strain on the heart must also be counted with. It must also be remembered that a slow progression to which the patients by and by adopt themselves make any cardiac symptom less disturbing. If in spite of certain warnings the patient's mental power urges him on, a state of provocation is produced. Büchner (1932) points to the attacks of angina pectoris as warnings, particularly as the muscular wall of the left ventricle is damaged both reversibly and irreversibly by coronary insufficiency earlier than other parts of the heart. Angina pectoris would then take a necessary load off the heart before it is definitely damaged and becoming insufficient. Complete rest in bed as Freedberg et al. (1948) suggest in case of »coronary failure» would then after a prolonged attack of angina pectoris act as a safeguard against a developing cardiac infarct.

That angina pectoris as a symptom of coronary insufficiency does not always precede an acute attack of cardiac infarct is pointed out by Eckerström and others. Eckerström found in his material of 242 infarct cases that 90 (37.2 %) never had had an anginous attack



before, or at the onset of the infarct. In the material of Gertler et al. embracing the ages of 20—40, all with cardiac infarcts, 64 % of them had had cardiac trouble earlier than the acute attack. Angina pectoris was present in 41 %.

It seems, however, difficult to judge the severity of an attack by the presence or absence of a preceding angina pectoris seizure. As O. Jervell and Eitinger (1950) put it: it is a subjective symptom. In different individuals it is a question of varying sensitivity to pain, and the threshold for pain may be lowered for some reason or other. I wish to add that neither in case of an acute attack of cardiac infarct which may run its course without angina pectoris do different degrees of pain give any lead as to judging the prognosis. The mortality in Eckerström's material was equally great among infarct cases with angina pectoris as without this symptom. From all textbooks of pathology it is evident that scars in the myocardium are common even in cases where no symptoms of infarct have been reported.

In my material of 232 cases 151 ( $65.1 \pm 3.1$  %) had suffered earlier from cardiac complaints, 98 of them with angina pectoris which had thus occurred in  $42.2 \pm 3.2$  % of the total number. The other 81 ( $34.9 \pm 3.1$  %) had developed their cardiac symptoms only in connection with the infarct. 70 of them were admitted the same day or a few days after the attack. In 11 cases the trouble had manifested itself during the 2—3 weeks before admission.

### *Releasing causes*

In Table 19 the releasing causes, which in the different cases have had connection with the symptoms of the developing cardiac infarct, have been compared. Such causes have been traced in 77 cases ( $33.2 \pm 3.1$  %). Of them 43 have had previous heart complaints, 21 of them with angina pectoris. Earlier heart complaints were absent in 34 cases and the infarct disease started without any previous cardiac symptom, and in 47 cases without any provocative cause ( $20.3 \pm 2.6$  %).

The bodily exertion mentioned in this Table has in most cases not been of a particularly heavy character. In some cases they have

TABLE 19

*Symptoms of Cardiac Infarct occurring in connection with:*

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Physical exertion: (felling timber 2, harvesting 3, carrying fire-wood 1, fetching water 1, shovelling snow 1, window cleaning 1, rowing 1, stoking a boiler 1, forging 1, using a jack 1, lifting planks 1, removing a horse-blanket 1, digging a ditch 1, garden work 1, setting potatoes 1, picking berries 1, cycling 5, pushing a sledge 1, running up-stairs 1, dancing 1, catching a bus 1, walking 13, mountaineering 1, longer journey by railway or car 4, defecation 1) ..... | 47        |
| Mental strain .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3         |
| Mental trauma .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3         |
| Sudden diarrhoea .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3         |
| Bleeding ulcer ventriculi .....                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2         |
| Gastritis haemorrhagica .....                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1         |
| Spinal anaesthesia .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1         |
| Asthma bronchiale .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1         |
| Lymphadenosis .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1         |
| Infections (acute bronchitis 5, endocarditis 1, cysto-pyelitis 2, cholecystitis 1, thyreoiditis 1) .....                                                                                                                                                                                                                                                                                                                                                                                 | 10        |
| After heavy meal .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 5         |
| <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>77</b> |
| While resting (in the evening after the work is ended 11, during the night while sleeping 40, in the morning before beginning work 4).                                                                                                                                                                                                                                                                                                                                                   |           |
| <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>55</b> |

been listed as unusual work done by the persons concerned or else the exertion has been under psychic pressure. It is of particular interest to note that so many cases were taken ill while working with their arms and in this connection I wish to allude to the intimation of Ask—Upmark (1944) that development of heart trouble very often occurs while doing work where the arms are particularly engaged, which would be explained by the heart and the arms belonging to the same neuromeres. Some of the work was carried out in a bending-forward position which is particularly trying for persons with cardiac trouble.

The shock cases are represented by 3 cases of sudden diarrhoea, and 2 cases with a serious bleeding from a gastric ulcer and finally one case shortly after introduced spinal anaesthesia before an opera-

tion for a perforated gastric ulcer which in itself had not affected greatly the general condition. This patient was also affected by a concurrent encephalomalacia. To this group of shock cases may also be added 3 cases of severe psychic trauma followed by a peracute symptom of infarct setting in. There were also 3 cases where the symptoms of infarct developed under particularly tense and psychic work.

Infections observed have in themselves not been of particularly severe character, but they have occurred in persons who earlier have shown evidence of coronary insufficiency and in some cases have been very much run down. It appears very likely to me, and this has been stressed earlier by other workers, that the number of acute catarrhal infections would be increased if critically observed and that such infections play an important part in provoking infarcts, a condition one should count with more often than what is done.

Taking into consideration the connection between certain abdominal diseases and cardiac infarct, referred to earlier in this work, I have reviewed the material from this standpoint. Here I wish to mention that gastric or duodenal ulcers were present in 15 cases (average age among the affected 60.2 years) and cholelithiasis in 18 cases (average age 66.2 years). In none of the ulcer cases was it a case of acutely worsening conditions except in the 2 patients with haemorrhage and one with a perforation. Nor was there in any one case an acute attack of cholelithiasis and in only one patient was there an acute cholecystitis as complication.

It is striking, however, and this has been mentioned by other workers, the great number of cases being affected during rest and sleep. In Master's (1937) material this occurred in 40 %. In our material there were 55 (23.7 %) such cases out of which 40 (17.2 %) had the attack during the night and while asleep. Only in 3 of the latter cases were there specific prodromal symptoms earlier during the day but they were slight and any particular and releasing cause could not be mentioned.

Generally one seems inclined to consider cold as a contributing factor in producing a cardiac infarct. Wilson and Finch (1923) pointed to changes in the ECG after drinking ice-water, and A. Jervell

TABLE 20

*Number of Cardiac Infarct Cases.*

|            |    |      |                                     |           |
|------------|----|------|-------------------------------------|-----------|
| Dec. ....  | 12 | } 55 | Winter half-year<br>Oct.—March      | 113 cases |
| Jan. ....  | 28 |      |                                     |           |
| Febr. .... | 15 |      |                                     |           |
| March ...  | 10 | } 60 | Summer half-year<br>April—September | 119 cases |
| April .... | 27 |      |                                     |           |
| May ....   | 23 |      |                                     |           |
| June ....  | 17 | } 49 |                                     |           |
| July ..... | 23 |      |                                     |           |
| Aug. ....  | 9  |      |                                     |           |
| Sept. .... | 20 | } 68 |                                     |           |
| Oct. ....  | 29 |      |                                     |           |
| Nov. ....  | 19 |      |                                     |           |
| Total      |    | 232  |                                     |           |

(1935) after chilling the praecordium. Ask—Upmark (1953) emphasizes the correlation of reflexes between the skin and the coronary system with a lowering of the praecordial skin temperature at the time of an infarct. Gertler et al. (1951) have noticed that most cardiac infarcts occur during the cold season. Master et al. (1937) came to the conclusion that this could not be the case and that the development of an infarct occurred independently of climatic temperature changes. Table 20 gives a comparison of the Umeå infarcts with reference to the time of the year they have taken place. It shows that they have not occurred oftener during the cold season of the year than during the summer-half of the year. Considering the long and severe winters which are the rule in Västerbotten, during which time the lumbermen in particular have to work out-of-doors and very often in very low temperature, the connection between cardiac infarct and cold ought to be apparent here. From this Table it is evident that cold has had no influence on the production of cardiac infarct in this material. It is possible that persons, who have anginous troubles feel these exaggerated in the cold, and arrange their living conditions accordingly. The possibility of an increased acquired tolerance against cold cannot be excluded.

It has already been shown that there is a relatively greater fre-

quency of admission of infarct cases from towns and municipalities than from the country districts. In order to investigate the provoking elements, as shown in Table 19, and their importance here I have scrutinized the material in this respect. The figures are altogether too small to furnish enough and certain evidence. It ought to be said that there is an excess in this Table of those included as admitted from towns and municipalities with 46 cases and 31 from the country side. Even of the obese, the lean and the hypertensive cases there was a greater admission from towns and municipalities. Regarding the 47 cases getting an attack after provocation by bodily exertion the same ratio persists with 27 cases from towns and municipalities as against 20 from the country. It should be mentioned that among the 20 cases from the country there were 7 obese but only one lean, further 11 with hypertension out of which number 4 were obese and 1 lean. According to this comparison also the lean ones from the countryside are those best off.



## Chapter 3

### *Observations at the Autopsies*

As a review of the autopsy findings ought to furnish valuable information I have made a comparison of these findings obtained from the post-mortem examinations. Of the 74 cases which ended fatally 69 were submitted to an autopsy. In addition to macroscopic examination, microscopic examination was also made in certain cases in order to clench the diagnosis of infarct. In all these cases evidence of fresh myocardial infarcts was noticed.

#### *a) Gradation of Arteriosclerosis, Age, Sex, Place of Residence, Nutritional Condition, Blood Pressure, Diabetes*

The arteriosclerosis has been named the chief cause of cardiac infarct. From Table 21 a. it is clear that arteriosclerotic changes in the coronary vessels were present in all autopsy cases. They were of a mild form in 4 ( $5.8 \pm 2.8 \%$ ), average in 13 ( $18.8 \pm 4.7 \%$ ), very marked in 52 ( $75.4 \pm 5.2 \%$ ).\*)

I have already pointed out certain conditions being of importance for the origin and development of arteriosclerosis in the admitted patients and discussed their importance in this material. In Tables 21 a. and b. follows a survey of the autopsy material along similar lines with gradation of the coronary sclerosis as a starting point for splitting up the material. Table 21 a. shows that the majority of those having a post-mortem examination were men ( $66.7 \pm 5.7 \%$ ). The percental distribution of the number of coronary sclerosis of various grades is on the whole equal for the two sexes,  $76.1 \pm 6.3 \%$

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\*) The gradation of arteriosclerosis has been classified according to the scheme adopted by the International Society for Geographic Pathology and this has also been used by Lundquist and Björnwall (1936). Only the state of the coronary arteries has been recorded. Group 1 and 2 have been combined and is here called mild coronary sclerosis. Group 3 and 4 is called average and group 5 and 6 termed very marked arteriosclerosis.

TABLE 21 A

*Stage of coronary sclerosis in male and female patients and in the different age groups; cases from towns and municipalities and from country districts.*

| Stage of coronary sclerosis | Number of cases | Sex |    | Age and Sex |    |       |    |       |    |       |    |      |    | Place of residence       |                   |
|-----------------------------|-----------------|-----|----|-------------|----|-------|----|-------|----|-------|----|------|----|--------------------------|-------------------|
|                             |                 | M.  | F. | 40-49       |    | 50-59 |    | 60-69 |    | 70-79 |    | ≥ 80 |    | Towns and Municipalities | Country Districts |
|                             |                 |     |    | M.          | F. | M.    | F. | M.    | F. | M.    | F. | M.   | F. |                          |                   |
| Mild .....                  | 4               | 3   | 1  | 2           | —  | —     | 1  | —     | —  | 1     | —  | —    | —  | 2                        | 2                 |
| Average ...                 | 13              | 8   | 5  | —           | —  | 1     | 1  | 5     | 3  | 2     | 1  | —    | —  | 5                        | 8                 |
| Very marked                 | 52              | 35  | 17 | 3           | —  | 8     | 1  | 10    | 10 | 13    | 6  | 1    | —  | 35                       | 17                |
| Total                       | 69              | 46  | 23 | 5           | —  | 9     | 3  | 15    | 13 | 16    | 7  | 1    | —  | 42                       | 27                |

TABLE 21 B

*Stage of coronary sclerosis in different nutritional conditions and in relation to blood pressure and diabetes mellitus.*

| Stage of coronary sclerosis | Number of cases | Nutritional Condition |          |        | Blood Pressure |        |           | Diabetes mellitus |
|-----------------------------|-----------------|-----------------------|----------|--------|----------------|--------|-----------|-------------------|
|                             |                 | Obesity               | Leanness | Normal | Hypertonia     | Normal | Uncertain |                   |
| Mild .....                  | 4               | —                     | —        | 4      | 1              | 2      | 1         | —                 |
| Average .....               | 13              | 4                     | —        | 9      | 6              | 4      | 3         | 1                 |
| Very marked.                | 52              | 22                    | 14       | 16     | 28             | 14     | 10        | 5                 |
| Total                       | 69              | 26                    | 14       | 29     | 35             | 20     | 14        | 6                 |

of the men with very marked coronary sclerosis and  $73.9 \pm 9.2$  % of the women. The distribution according to age shows the greatest group (28 cases) 60—69 years of age. Most of the cases were above 59 (52). In the age group below 60 the men were in the majority (14 out of 17) and in the group 40—49 only men were found. Very marked coronary sclerosis was found in all the age groups with a tendency towards a clearly marked frequency in the oldest age group, 60.0 % in the 40—49 years, 75.0 % in the 50—59 years, 71.4 % in the 60—69 and 82.6 % in the age group 70—79 years of age. These

groups are noticeably small and the difference is hardly statistically guaranteed on this material. It is noteworthy that one man in age group 70—79 had only mild coronary sclerosis. Otherwise mild coronary sclerosis occurred in 2 men of group 40—49 and in one woman of group 50—59. Of the 14 men below 60, 11 had very marked coronary sclerosis. In this age group there were only 3 women, and of them one had very marked coronary sclerosis. In the older age groups there was an equal sex distribution. Of the 32 men in the age group 60 and above 24 ( $75.0 \pm 7.7 \%$ ) had very marked coronary sclerosis and of the 20 women in the same group 16 ( $80.0 \pm 8.9 \%$ ) had the same very marked sclerosis. — Table 21 a. shows also that the majority ( $60.9 \pm 5.9 \%$ ) came from towns and municipalities, and that the cases with very marked coronary sclerosis were relatively more numerous here than among those from the country side, ( $83.3 \pm 5.8 \%$  as against  $63.0 \pm 9.3 \%$ ). The difference is, however, not statistically guaranteed. The majority of hypertensive cases came also from towns and municipalities (21 of 35). Twelve of the hypertensive cases, of whom 11 were men and one woman, all below 60 years of age and with marked coronary sclerosis came from these places.

Among the 101 cases undergoing a post-mortem examination at Umeå Hospital 1933 not a single case of very marked arteriosclerosis was noted (Lundquist and Björnwall 1936) while in the present material submitted to autopsy during 1939—1950 there were no less than 52 cases with very marked coronary sclerosis. 1949 and 1950 show the highest figure with 11 cases each year. I have previously referred to the observation of Lundquist with regard to the increased frequency of arteriosclerosis among the autopsy cases in this hospital and its connection with the increased average age. In this infarct material as well there is a definite increase of elderly people, which also corresponds with an increased number of very marked coronary sclerosis. During 1949—1950 there were 12 cases in the age group 70—79 while this same number forms a total during the period 1939—1948.

The connection between obesity, hypertension, diabetes and arteriosclerosis has previously been stressed and with it the increasing tendency to cardiac infarct. In order to find a connecting link between cardiac infarct following these diseases and coronary sclerosis in its

various grades I have in Table 21 b. made a comparison of the infarct cases with a starting point from the different nutritional conditions, blood pressure and diabetes in relation to the three grades of coronary sclerosis. This Table shows that a nutritional condition of obesity was found in 26 ( $37.7 \pm 5.8 \%$ ), leanness in 14 ( $20.3 \pm 4.8 \%$ ) and a normal condition in 29 cases ( $42.0 \pm 5.9 \%$ ). The lean ones made up the smallest group. Very marked coronary sclerosis was found in most of the different age groups with a slight excess in the number of the obese, who numbered 22. Among the obese very marked coronary sclerosis was found in  $84.6 \pm 7.1 \%$ , and among the normal in  $55.2 \pm 9.2 \%$ . The difference is most likely statistically correct  $29.4 \pm 11.6 \%$ . It is noteworthy that all the 14 lean ones had very marked coronary sclerosis. 8 of them had in addition hypertension. 11 were 60 years of age or above, and 7 of them suffered from diseases, each of which may be accompanied by leanness. That loss of weight had occurred even among the «normal» cases seems a fact to be reckoned with.

Deducting these cases affected by special conditions the fact remains that very marked coronary sclerosis was found in a higher percentage among the obese as compared with the «normal» or the material taken as a whole. There is reason to believe that obesity would be a predisposing factor to cardiac infarct in case of very marked coronary sclerosis, but that other factors as well have their influence. In this connection it may be mentioned that the 4 cases with mild coronary sclerosis were in normal nutritional condition. Even among these cases there were diseases which could be termed contributive, a subject I shall return to later on.

As regards the comparison where the blood pressure has been used as a basis it must be said that in the majority where the blood pressure has been recorded as «uncertain» it was very likely a case of hypertension, for they had a cardiac hypertrophy without any other obvious reason. Hypertension was found in 35 ( $50.7 \pm 6.0 \%$ ), normal blood pressure in 20 ( $29.0 \pm 5.5 \%$ ) and the «uncertain» amounted to 14 cases ( $20.3 \pm 4.8 \%$ ). The hypertensive cases thus made up the largest group and they would most likely be added to by including several of the «uncertain» ones.

Very marked coronary sclerosis was found among the majority of the different categories — in the hypertensive cases with  $80.0 \pm 6.8 \%$  and in those with normal blood pressure in  $70.0 \pm 10.2 \%$ . Very marked coronary sclerosis was also relatively more common among the hypertensive cases than in the whole material. No great difference in the percental was noticed. Just as it was among the obese patients there seems to be a tendency towards increased risk for infarct among the hypertensive cases in case of very marked coronary sclerosis. But even among them the combination of mild coronary sclerosis was observed. The patient was a 58 year old, married woman, who had a unilateral atrophied kidney and stenosis of the aortic as well as of the mitral valves and a pronounced cardiac hypertrophy (case No. 1 in Table 26).

Of the 6 diabetic patients 5 had coronary sclerosis of a very marked degree, and one case of average degree.

Thus it follows from the comparison in Tables 21 a. and b. that very marked coronary sclerosis was present in a clear majority of cases, often appearing earlier in the men than in the women but in particular showing up in older patients without any difference as to sex; this number has increased during the latter years. Very marked coronary sclerosis occurred in the majority of diabetics, more often in those coming from towns and municipalities than among those from the country side, and oftener in those who suffered from hypertension than in those with normal blood pressure. As regards the different nutritional conditions the picture is not equally clear, but very marked coronary sclerosis was definitely more common in connection with obesity than in those with normal nutritional condition, and with reference to the lean ones there were specially predisposing factors. — Principally this conforms with what has earlier been seen of cardiac infarct in the different categories of admitted patients. On this basis it seems conclusive that the conditions, and the tendency associated with them for production of cardiac infarcts, were present. They have also contributed to the causing of the very marked coronary sclerosis.

It may be of interest to add that the combination of obesity and hypertension was present in 14 cases, and that out of this number 12



had coronary sclerosis of a very marked degree and 2 of the average type. Among those 52 cases who were 60 years of age and above very marked coronary sclerosis plus obesity and hypertension occurred in 10 cases ( $19.2 \pm 5.5 \%$ ). Among 17 cases below 60 years of age this combination occurred in 2 cases ( $11.8 \pm 7.8 \%$ ). Average coronary sclerosis was present in the same combination in 2 cases of the oldest but in no case among the younger. Wilens (1947) came to the conclusion that age, obesity and hypertension, which separately are considered to have a connection with arteriosclerosis and its development, certainly act independently, but that the greater number of cases of arteriosclerosis is to be found where these three factors act in conjunction. The relatively low number in the Umeå material does not permit final conclusion in this respect. It is suggestive, however, that the figures obtained here show the same tendency as those of Wilen's material which would indicate that the combination referred to results in the greatest predisposition to coronary sclerosis and cardiac infarct.

#### b) *The Origin of Cardiac infarct*

Though the origin of cardiac infarct is favoured by the presence of a very marked coronary sclerosis it is not fully explained why and in what manner the infarct has originated in the different cases. Still less does this apply when considering the milder forms of coronary sclerosis.

#### *Occlusion or no Occlusion*

Table 22 shows that there was occlusion in 35 cases ( $50.7 \pm 6.0 \%$ ), in 30 cases caused by a thrombus, in 4 cases owing to a stricture on arteriosclerotic basis (of these one case had a combination with thrombosis), and in one case there was an embolus. Thrombosis was thus present in 31 cases ( $44.9 \pm 6.0 \%$ ) of the total autopsy material. In 30 ( $85.7 \pm 5.9 \%$ ) of these cases of occlusion there was very marked coronary sclerosis, in the other 5 a coronary sclerosis of average type. There were, however, 34 ( $49.3 \pm 6.0 \%$ )

TABLE 22

*Occlusion and no occlusion at different stages of coronary sclerosis and cardiac hypertrophy.*

| Occlusion      | Number of cases | Coronary sclerosis |         |      | Cardiac Hypertrophy*) |         |     |
|----------------|-----------------|--------------------|---------|------|-----------------------|---------|-----|
|                |                 | v. marked          | average | mild | marked                | average | nil |
| Thrombosis ..  | 30              | 25                 | 5       | —    | 19                    | 10      | 1   |
| Stricture .... | 4               | 4**)               | —       | —    | 2                     | 1       | 1   |
| Embolus ....   | 1               | 1                  | —       | —    | 1                     | —       | —   |
| Total          | 35              | 30                 | 5       | —    | 22                    | 11      | 2   |
| No Occlusion   | 34              | 22                 | 8       | 4    | 27                    | 6       | 1   |

\*) Weight of Heart: more than 500 Gm=marked hypertrophy

400—500 Gm=average »

less than 400 Gm=nil »

\*\*) of these one case with thrombosis as well.

cases without any evidence of arterial occlusion. Among them very marked coronary sclerosis was present in 22 ( $64.7 \pm 8.2$  %). In addition there were 8 cases with average coronary sclerosis and 4 where there was a mild form characterized only by smaller atheromatous patches.

From this follows that the cases with and without occlusion were about the same in number but that occlusion was more common where a very marked coronary sclerosis was present. It is also evident that there was no occlusion in those cases where only a mild form of coronary sclerosis was present. Occlusion in most cases had taken place by means of thrombus formation. In 4 cases only there was a vascular stricture, and in one case an embolus. Disregarding the latter five cases it is difficult to say why in one case and not in another occlusion has taken place. This concerns particularly the cases with very marked coronary sclerosis where the pre-requisite condition for an occluding process ought to have had the same chance to develop considering the vascular disease. It appears as most likely to me that the local changes in the vessel being the cause with formation of an

occluding thrombus (as seen in the case where the stricture was combined with a thrombus). That no occlusion takes place in the mild form of coronary sclerosis gives support to this theory.

An increased tendency to coagulation, which certain investigations have pointed to in connection with cardiac infarct, would encourage the production of a thrombus. Blumer (1937) found thrombo-embolic complications in cardiac infarct cases, arising from mural thrombosis in 50 % of his cases. Overman and I. S. Wright (1951) pointed out that hyperprothrombinaemia was characteristic of cardiac infarct cases in comparison with normal persons. But here I wish to draw attention to Klemensievics (1912) who wrote that in the case of ischaemia there is a disturbance of the permeability of the vessel wall which results in an oedema of the vessel wall and with organic damage. This would, in its turn, result in thrombus formation. Under such conditions the thrombosis would rather be the result than the cause of the myocardial ischaemia. It may be noted that Horn and Finkelstein (1940) consider an intra-mural bleeding of a sclerotic artery of importance for the production of a coronary thrombosis. In a material of 100 cases with acute coronary occlusion they found in 62.5 % this to be directly caused by a massive haematoma of the intima, and in 37.5 % by thrombus formation on an arteriosclerotic plaque following acute changes in the tissues as a result of an intra-mural bleeding. The primary importance of thrombosis in the production of an infarct, according to what has been said, would be reduced. If thrombosis occurs it undoubtedly produces a serious complication.

### *The Size of the Heart*

When an infarct may apparently form equally well with, as well as without occlusion, and when the grade of the coronary sclerosis is not decisive, the question arises as to what else is of importance for the production of an infarct. I have earlier touched upon this subject and noted certain diseases which, besides the coronary sclerosis, may play a part and hamper the nutrition of the heart muscle. Among these factors cardiac hypertrophy only has been taken up for

TABLE 23

*Different stages of cardiac hypertrophy with varying blood pressure and nutritional conditions and at different stages of coronary sclerosis, with and without occlusion.*

a.

| Cardiac Hypertrophy | Blood Pressure |       |           | Nutritional Cond. |       |      | Coronary Scler. |      |      | Occlusion |        |      | No Occlusion |
|---------------------|----------------|-------|-----------|-------------------|-------|------|-----------------|------|------|-----------|--------|------|--------------|
|                     | Hypert.        | Norm. | Uncertain | Obese             | Norm. | Lean | V. mark.        | Ave. | Mild | Thromb.   | Stric. | Emb. |              |
| Marked .. 49        | 27             | 12    | 10        | 16                | 23    | 10   | 36              | 9    | 4    | 19        | 2      | 1    | 27           |
| Average .. 17       | 6              | 7     | 4         | 8                 | 6     | 3    | 14              | 3    | —    | 10        | 1      | —    | 6            |
| Nil ..... 3         | 2              | 1     | —         | 2                 | —     | 1    | 2               | 1    | —    | 1         | 1      | —    | 1            |
| Total 69            | 35             | 20    | 14        | 26                | 29    | 14   | 52              | 13   | 4    | 30        | 4      | 1    | 34           |

Occlusion.

No Occlusion.

b.

| Card. Hypertrophy | Coronary Sclerosis |         |      |
|-------------------|--------------------|---------|------|
|                   | Very marked        | Average | Mild |
| Marked .. 22      | 19                 | 3       | —    |
| Average .. 11     | 9                  | 2       | —    |
| Nil ..... 2       | 2                  | —       | —    |
| Total 35          | 30                 | 5       | —    |

c.

| Card. Hypertrophy | Coronary Sclerosis |         |      |
|-------------------|--------------------|---------|------|
|                   | Very marked        | Average | Mild |
| Marked .. 27      | 17                 | 6       | 4    |
| Average .. 6      | 5                  | 1       | —    |
| Nil ..... 1       | —                  | 1       | —    |
| Total 34          | 22                 | 8       | 4    |

discussion in Table 23. The other factors have been too few for special comparison. Most of them, however, have been listed in Table 26. Nor have I included cardiac insufficiency for scrutiny as it would be difficult to judge in the different cases if the infarct is not the cause of cardiac insufficiency.

Table 23 a. shows that cardiac hypertrophy was present in 66 (95.7  $\pm$  2.4 %) of the 69 autopsy cases. In 49 cases (71.0  $\pm$  5.5 %) it was very marked, in 17 (24.6  $\pm$  5.2 %) average. In 3 cases (4.3  $\pm$  2.4 %) there was no enlargement at all. In these 3 latter cases 2 showed coronary sclerosis with occlusion, in one of them with stricture of the vessels, in the other by means of thrombus. In the third

case raised atheromatous plaques were bulging into the lumen, but not enough to cause an occlusion.

Half the number of cardiac hypertrophy cases were complicated by hypertension. Among the 66 cases hypertension was present in 33 ( $50.0 \pm 6.2 \%$ ) and among the group of 49 cases with marked enlargement in 27 ( $55.1 \pm 7.1 \%$ ). The number of hypertensive cases could most likely be increased by adding the majority of »uncertain» cases. Normal blood pressure was found in a quarter of the cases with marked cardiac hypertrophy. It ought to be mentioned that in 2 cases with hypertension and occlusion there was no cardiac enlargement.

Comparing the size of the heart and its relation to different nutritional conditions it is seen that among the cardiac hypertrophy cases there were 24 ( $36.4 \pm 5.9 \%$ ) obese, 29 ( $43.9 \pm 6.1 \%$ ) normal and 13 ( $19.7 \pm 4.9 \%$ ) lean ones. Leanness occurred least among the cases of cardiac enlargement. It may be mentioned that obesity was not in preponderance among those who had the most advanced hypertrophy. An explanation of this state of affairs is to a certain degree to be found in the loss of weight following the disease before death.

Among the cases of cardiac hypertrophy very marked coronary sclerosis was observed in 50 ( $75.8 \pm 5.3 \%$ ). Very marked coronary sclerosis and cardiac hypertrophy thus usually occurred together. In 2 cases, however, with markedly advanced coronary sclerosis no enlargement was seen, and in 4 cases with mild coronary sclerosis severe cardiac enlargement was observed. The significance of vascular changes in the production of a cardiac infarct will be discussed further in connection with Table 26. I will only refer here to the 2 cases without cardiac enlargement but with grave vascular changes which give a clue to what may be considered essential for the production of an infarct. From the comparison of the cases with occlusion and those without occlusion in Table 23 a. it is further shown that among those with cardiac hypertrophy there were 33 ( $50.0 \pm 6.2 \%$ ) cases with occlusion and the same number without occlusion. Among those with severe cardiac hypertrophy there were 22 ( $44.9 \pm 7.1 \%$ ) with occlusion as against 27 ( $55.1 \pm 7.1 \%$ ) without occlusion. The number of



no-occlusion cases was thus slightly more common with severe cardiac hypertrophy.

Table 23 b. shows a comparison of the 35 occlusion cases according to different grades of cardiac size and the type of coronary sclerosis which show that no single case of mild coronary sclerosis is included here. Very marked coronary sclerosis was seen in 30 ( $85.7 \pm 5.9 \%$ ) cases. Among the 33 with cardiac hypertrophy very marked coronary sclerosis was seen in 28 ( $84.8 \pm 6.2 \%$ ), and among the 22 with severe cardiac enlargement 19 ( $86.4 \pm 7.3 \%$ ) had very marked coronary sclerosis. — Table 23 c. shows the type of the coronary sclerosis in 34 no-occlusion cases with different grades of cardiac enlargement. Very marked coronary sclerosis was found among 22 ( $64.7 \pm 8.2 \%$ ). It is noteworthy that 4 with a mild coronary sclerosis had marked cardiac hypertrophy. This is explained in 3 cases by valvular disease and in the fourth case by a nephrosclerosis. Of 33 with cardiac hypertrophy 22 had very marked coronary sclerosis ( $66.7 \pm 8.2 \%$ ), and among 27 with marked enlargement of the heart very marked coronary sclerosis was found in 17 ( $63.0 \pm 9.3 \%$ ). — From this it is evident that in cases of occlusion it was the changes in the coronary vessels which played the greatest part, while they were less important in cases of no-occlusion where the cardiac hypertrophy was most pronounced.

### *Releasing Causes*

I have also taken up the question as to whether the autopsy material may furnish a clearer picture regarding the provoking element and its significance to decide the production of cardiac infarct in this material. I am anxious to do this considering that Master (1947) maintains, as is mentioned before, that provoking elements as a rule are of no importance in coronary occlusion.

The comparison in Table 24 shows that provoking elements were obtained in 21 cases ( $30.4 \pm 5.5 \%$ ) of which 11 were cases with occlusion and 10 without occlusion, and this was found at the post-mortem examination. Further it was noticed that among the 21 cases, where a provoking element was known, there were 14 ( $66.7 \pm$

TABLE 24

*Releasing elements in cases with occlusion and with no occlusion;  
at different stages of coronary sclerosis and  
various nutritional conditions.*

| Releasing Elements |    | Occlusion | No Occlusion | Coronary Sclerosis |         |      | Nutritional Cond. |        |      |
|--------------------|----|-----------|--------------|--------------------|---------|------|-------------------|--------|------|
|                    |    |           |              | V. marked          | Average | Mild | Obese             | Normal | Lean |
| Present ....       | 21 | 11*)      | 10**)        | 14                 | 7       | —    | 9                 | 8      | 4    |
| Non-present        | 48 | 24        | 24           | 38                 | 6       | 4    | 17                | 21     | 10   |

\*) Physical exertion ..... 5 cases  
Heavy meal ..... 1 case  
Diarrhoea ..... 2 cases  
Haemorrhagic gastritis . 1 case  
Infection ..... 2 cases

\*\*) Physical exertion .... 5 cases  
Mental strain ..... 1 case  
Bleeding ulcer ..... 1 case  
Infection ..... 3 cases

10.3 %) with very marked coronary sclerosis, while among 48 cases where no provoking cause was known, 38 (79.2  $\pm$  5.9 %) had very marked coronary sclerosis. Regarding the four cases with only mild coronary sclerosis there was no known provoking cause. As in the material presented by Gr ner and Hilden (1951), and as a contrast to Master's (1947), this material has shown that releasing elements were present equally often in occlusion cases as in the no-occlusion cases. It has also been shown that the grade of coronary sclerosis has not been a decisive factor whether the production of an infarct has occurred in connection with a provoking cause or not.

The Table shows besides that obesity may have had a certain influence in the production of an infarct in considering the strain noted. Among the provocation cases there were obese patients in 42.9  $\pm$  10.8 % as against 35.4  $\pm$  6.9 % in other cases. In the provocation group were further included 38.1  $\pm$  10.6 % »normal« as against 43.8  $\pm$  7.2 % »normal« in the other group, and 19.0  $\pm$  8.6 % lean cases as against 20.8  $\pm$  5.9 % lean ones of the no-provocation cases.

TABLE 25

*Previous cardiac complaints with different stages of coronary sclerosis and cardiac hypertrophy.*

| Cardiac complaints    | Number of cases | Coronary Sclerosis |         |      | Cardiac Hypertrophy |         |     |
|-----------------------|-----------------|--------------------|---------|------|---------------------|---------|-----|
|                       |                 | Very marked        | Average | Mild | Marked              | Average | Nil |
| Angina pectoris ..... | 32              | 28                 | 4       | —    | 26                  | 5       | 1   |
| Other .....           | 13              | 10                 | 1       | 2    | 11                  | 2       | —   |
| Nil .....             | 24              | 14                 | 8       | 2    | 12                  | 10      | 2   |
| Total                 | 69              | 52                 | 13      | 4    | 49                  | 17      | 3   |

### *Previous Heart Complaints*

It has earlier been mentioned that it is not uncommon to find that previous heart complaints have been non-existent before the attack of the acute cardiac infarct. Similar observations, and noted in the case history have also been made in connection with the post-mortem examination. Here again the furnished information submitted by the patient himself has to be received with reservation on account of the difficulty in getting a true account from a sick person. From Table 25 it is evident that previous heart complaints have been mentioned by 45 ( $65.2 \pm 5.7$  %) patients, and angina pectoris by 32 ( $46.4 \pm 6.0$  %). Very marked coronary sclerosis present in 52 had been connected with cardiac complaints in 38 ( $73.1 \pm 6.1$  %) and with angina pectoris in 28 ( $53.8 \pm 6.9$  %), but was also present in 14 without any heart complaint.

Even if very marked coronary sclerosis and heart complaints with angina pectoris — in the majority a common combination — it is evident from this Table that the type of the coronary sclerosis has not been a factor as to the presence of earlier heart complaint or not. The formation of anastomoses may be of importance (Blumgart et al. 1940). The Table also shows that the heart complaints have occurred at various stages of cardiac enlargement in the same manner as

in different types of coronary sclerosis. It may further be said that it is not a rule that angina pectoris is a warning of coronary thrombosis. In 30 cases of thrombosis angina pectoris only manifested itself previously in 11 cases.

### *Cardiac Infarct with Average and Mild Coronary Sclerosis*

It has already been mentioned that the stage or type of coronary sclerosis is not decisive for the development of an infarct. The 13 cases which at the time of post-mortem examination proved to have average arteriosclerotic manifestations in the coronary vessels, and particularly the 4 cases where only mild coronary sclerosis was seen, ought to furnish evidence as to whether, and in what manner, functional disturbances in particular would cause the development of an infarct of the heart. Table 26 gives a comparison of these 17 cases with short notes of particular interest on the clinical and pathological findings. In the cases 1 to 4 the coronary sclerosis was mild, in 5 to 17 of an average degree.

Coronary occlusion was found in the cases 13 to 17. This was caused by thrombosis and the acute infarctuous process corresponded to this occlusion. Cardiac hypertrophy was present in all these five cases and the reason for this is classified as hypertension in the cases 13, 14, 15 and 16. Moreover in cases 15 and 17 fibrosis was found as evidence of an earlier infarct.

In the cases 5 to 12 no occlusion could be observed. Among them cardiac hypertrophy was seen in all, except in case 11. The cause of the hypertrophy was hypertension in 5, 7, 8 and 9, possibly also in cases 6 and 12. In the cases 6, 7, 8, 10 and 12 infarctuous fibrosis was seen. Obesity was present in cases 5, 6, 9 and 11. In case 10 there was a chronic bronchitis with pulmonary emphysema; further a fibrillation arrhythmia in cases 8, 9 and 12.

Even in the cases 1 to 4 occlusion was lacking. In all cases cardiac hypertrophy was present — in cases 1, 2 and 4 due to valvular disease of rheumatic origin (in case 4 also pericardial synechia), and in case

3 where the hypertension was caused by an arteriosclerotic cirrhosis of the kidneys. This case like case 1 also suffered from fibrillation arhythmia. Case 1 had in addition a right-sided atrophied kidney with hypertension, and in case 4 there was obesity.

Among the cases with occlusion the local atheromatous processes in the vessels seem to have given rise to stenosing conditions which have resulted in an occluding thrombus formation. In case 11 there was no definite occlusion, but the atheromatous stenosis formation appears to have produced a considerable hinderance to the blood supply. In the other cases, and here cases 1 to 4 in particular, it is difficult to draw any conclusion from the changes in the coronary vessels as regards their influence in producing an infarct. In all of them, however, cardiac disease of a different nature was present or some other disease which could have had a deleterious effect on the function of the heart or its blood supply by means of which the infarct formation would be favoured. In all cases except case 11 cardiac hypertrophy was evident, which according to what has been said before is enough to require a greater flow of blood. It is not unlikely that the cardiac hypertrophy, seen in the occlusion cases, by means of an ischaemic disturbance of the tissues contributed to the formation of a thrombus in these cases. Besides, it is noteworthy that there are signs of previous infarcts present in as many as 8 of the 17 cases, — providing thought for speculation that these most likely had a certain functional disposition for infarcts in spite of the relatively mild changes in the coronary vessels. What determined in this case or in others the formation of the infarct it is difficult to say either here or in the material already dealt with. Of the provoking elements noted in 10 of the cases there was bodily strain in 3 cases, psychic stress in one case and acute infections of various types in 8, in 2 of the latter also combined with bodily strain or exertion.

The clinical and pathologico-anatomical findings made in these cases of cardiac infarct with mild or average coronary sclerosis definitely indicate that the alterations of coronary vessels by themselves gave no explanation of the formation of an infarct. Changes in the heart of a different nature as well as other diseases affecting the nutrition of the heart in an adverse manner contributed to the formation



TABLE 26

*Comparison of the 17 cases with mild and average coronary sclerosis.*

| Case No.<br>Sex<br>Age                 | Clinical and pathologico-anatomical data |                                                                                  |                                            |                                                                           |
|----------------------------------------|------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------------|
|                                        | Heart                                    |                                                                                  | Kidneys                                    | Other                                                                     |
|                                        | Hypertrophy <sup>a)</sup>                | Other data                                                                       |                                            |                                                                           |
| <i>I. Mild Coronary Sclerosis.</i>     |                                          |                                                                                  |                                            |                                                                           |
| 1. 1174/41<br>F.<br>58                 | ++                                       | Insuff. trouble, sten. valv. mitr. et aortae,<br>Fibrillation.                   | Nephrit. chron. dext.                      | Hypertonia                                                                |
| 2. 2431/46<br>M.<br>49                 | ++                                       | Insuff. trouble, insuff. valv. mitr.,<br>infarctuous Fibrosis                    | —                                          | Bronchitis ac.                                                            |
| 3. 157/49<br>M.<br>79                  | ++                                       | Insufficiency trouble, Fibrillation                                              | Nephro-cirr. arterioscl.                   | Hypertonia                                                                |
| 4. 1673/50<br>M.<br>48                 | ++                                       | Insuff. trouble, synechia pericardii, sten.<br>valv. mitr., infarctuous Fibrosis | —                                          | Adipositas                                                                |
| <i>II. Average Coronary Sclerosis.</i> |                                          |                                                                                  |                                            |                                                                           |
| 5 a. 544/40<br>F.<br>64                | ++                                       | —                                                                                | Nephro-cirr. arterioscl.                   | Adipositas<br>Hypertonia<br>Bronchitis ac.                                |
| 6. 1738/42<br>M.<br>77                 | +                                        | Tachycardia, infarctuous Fibrosis                                                | Arterioscl. renum,<br>pyelonephrit. chron. | Bronchitis ac.<br>Panophthalmitis ac.<br>Hypertroph. prost.<br>Adipositas |
| 7. 1406/43<br>M.<br>68                 | ++                                       | Angina pect., infarctuous Fibrosis                                               | —                                          | Hypertonia<br>Emphysema pulm.                                             |

|       |                     |    |                                                                                        |                         |                                                                                                                            |
|-------|---------------------|----|----------------------------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 8.    | 40/47<br>F.<br>74   | ++ | Physical Exertion, Fibrillation,<br>infarctuous Fibrosis                               | Arterioscl. renum       | Hypertonia<br>Bronchitis ac.                                                                                               |
| 9.    | 1779/47<br>F.<br>56 | ++ | Angina pect., Fibrillation                                                             | Arterioscl. renum       | Hypertonia<br>Adipositas<br>Bronchitis ac.                                                                                 |
| 10.   | 1911/47<br>M.<br>68 | ++ | Physical Exertion, angina pect.,<br>infarctuous Fibrosis                               | —                       | TB. pulm. amb. sanat.<br>Adherens. pleur. bil.<br>Bronch. chr. c. exacer.<br>Emphys. pulm. Diab.<br>mellitus<br>Adipositas |
| 11.   | 714/50<br>M.<br>51  | —  | Mental Strain, long and projecting<br>atherom. plaque                                  | —                       |                                                                                                                            |
| 12.   | 2698/50<br>M.<br>66 | ++ | Fibrillation, infarctuous Fibrosis                                                     | Arterioscl. renum       | TB. chr. indur. pulm.<br>sin.                                                                                              |
| 13 b. | 561/46<br>M.<br>67  | +  | Raised atherom. plaques, coronary<br>thrombosis                                        | Arterioscl. renum       | Adher. pleur. sin.<br>Hypertonia<br>Bronchitis ac.<br>Bronchopneumonia<br>Hypertonia                                       |
| 14.   | 1197/46<br>F.<br>66 | ++ | Angina pect., atherom. changes with<br>some strict. of lumen, coronary<br>thrombosis   | Nephrocirr. arterioscl. |                                                                                                                            |
| 15.   | 482/47<br>M.<br>60  | +  | Physical Exertion, raised atherom.<br>plaques, coron. thromb., infarctuous<br>Fibrosis | Nephrocirr. arterioscl. | Hypertonia                                                                                                                 |
| 16.   | 2310/50<br>F.<br>63 | ++ | Ang. pect., raised ather. plaques,<br>coronary thrombosis                              | Arterioscl. renum       | Hypertonia                                                                                                                 |
| 17.   | 2953/50<br>M.<br>71 | ++ | Almost obliterating ath. plaques, coronary<br>thrombosis, infarctuous Fibrosis         | —                       | Bronch. chr. c. exac.<br>Emph. pulm., diarrh.<br>Splenit. ac. sept.                                                        |

\*) ++ = marked cardiac hypertrophy  
+ = average cardiac hypertrophy  
— = nil cardiac hypertrophy

of the infarct. That functional causes play an important part even in the presence of very marked coronary sclerosis have to be taken into consideration.

### c) *Electrocardiographic Examinations*

Electrocardiographic examinations have been made in 51 of the 69 cases submitted for post-mortem examination. Of these 29 had definite signs of infarct. In 13 cases the changes in the ECG indicated a likely infarct. In the other 9 the ECG pointed to signs of myocardial damage, but clear signs of infarct were missing in spite of clinical symptoms present. ECG examinations were made in one case among them within the first 24 hours, in one during the first 48 hours and in 2 after 72 hours after the attack; in one on the 4th day, in 2 on the 8th and in one on the 9th day. In addition one case was examined on admission 1 month after the attack. In 2 cases ECG examinations were continued until the 14th day without discovering any definite signs of infarct appearing.

At the autopsy it was found that these 9 infarcts were localized as follows: in the septum in 2 cases, in the posterior part of the left ventricle wall in 2 cases, in the anterior part of the left ventricle wall in 4 cases, and in the septum and in the anterior and posterior walls of the left ventricle in 1 case.

### d) *Localization of the Cardiac Infarct*

The localization of the cardiac infarcts in the 69 cases submitted for autopsy occurred as follows:

|                                |          |
|--------------------------------|----------|
| Anteriorly .....               | 23 cases |
| Posteriorly .....              | 20 »     |
| Anterior- and posteriorly .... | 7 »      |
| Septal .....                   | 5 »      |
| Septal and anteriorly .....    | 8 »      |
| Septal and posteriorly .....   | 6 »      |

The most common localization was, as is usually the case, an infarct of the anterior wall and this occurred in 38 cases ( $55.1 \pm 6.0 \%$ ). Infarcts of the posterior wall were observed in 33 cases ( $47.8 \pm 6.0 \%$ ) and the septal infarct in 19 cases ( $27.5 \pm 5.4 \%$ ). With very marked coronary sclerosis anterior wall infarct took place in 28 cases, posterior wall infarct in 27 and in the septum in 13 cases; with mild and average coronary sclerosis the figures were 10, 6 and 6 respectively. The severity of the coronary sclerosis has thus not determined the localization of the infarct in the different cases. Determining the localization of occlusion infarcts similar figures appear as for the whole of the material = viz. anterior wall infarcts in 23 cases, posterior wall infarcts in 13 and septal infarcts in 10 cases.

## Chapter 4

### *Recurrences*

Table 27 shows that recurrences occurred in 36 cases ( $15.5 \pm 2.4$  % of the total infarct material) of which 28 died (mortality  $77.8 \pm 6.9$  %). By means of ECG we know that 16 had had cardiac infarct before. 8 of them died and the same number survived. In two cases there was a second relapse. One died and the other survived. The other 14 among those 16 were, to the best of our knowledge, a first recurrence. The time interval between the first known and the last attack was 3 months to 8 years, to most of them about one year. Any obvious difference as to the time interval between the infarcts in those who died and those who survived is not apparent. It may, however, be noted that the shortest interval, 3 and 6 months, occurred in two who died.

Of the recurrent cases 29 were men and 7 women. The average age of the former was 62.2 and for the latter 64.6 years. The age of the men as well as of the women varied from 46—77 years. The greatest number was found in the age group 60—69 with 15 cases, of which 12 men and 3 women, 5 belonged to the age group 40—49, 4 of them men, and 7 in the age group 50—59, 6 of them men, 9 in the age group 70—79, 7 of them men.

Hypertension was present in 20 ( $55.6 \pm 8.3$  %), obesity in 10 ( $27.8 \pm 7.5$  %), leanness in 8 ( $22.2 \pm 6.9$  %), previous heart complaints in 26 ( $72.2 \pm 7.5$  %), angina pectoris in 18 ( $50.0 \pm 8.3$  %). 22 lived in towns and municipalities ( $61.1 \pm 8.1$  %), and 14 ( $38.9 \pm 8.1$  %) in the country. In 10 cases ( $27.8 \pm 7.5$  %) the infarct symptoms were connected with some provoking element. All the 28 fatal cases ( $40.6 \pm 5.9$  % of all undergoing autopsy) showed at the postmortem examination typical scarification after previous infarctions. In addition there were found in 10 cases more or less extensive areas of patchy fibrosis. In the 28 cases with scars of infarcts very marked coronary sclerosis was seen in 18 cases ( $64.3 \pm 9.1$  %), average form in 6 ( $21.4 \pm 7.8$  %) and mild form in 4 ( $14.3 \pm 6.6$  %).



TABLE 27  
*Recurrent cases.*

| Number of cases | Survived              | Deaths                |                          |
|-----------------|-----------------------|-----------------------|--------------------------|
|                 | Previous positive ECG | Previous positive ECG | Detected only at Autopsy |
| 36              | 8                     | 8                     | 20                       |

Marked cardiac hypertrophy was seen in 22 cases ( $78.6 \pm 7.8 \%$ ) and average form in 6 ( $21.4 \pm 7.8 \%$ ). Coronary occlusion occurred in 7. Among these no case was found which was previously known by means of a positive ECG.

In the main we find the same symptomatic picture among the recurrent cases as in those of the total material. The high mortality (77.8 %) is noteworthy. The duration of illness, as a rule, was protracted among them. Only 2 cases died during the first 3 days and 4 during the first week. None of the cases had so severe symptoms on admission that they were classified as shock cases (group 1). That cardiac hypertrophy as well as previous heart complaints were relatively more common among the recurrent cases than among the total infarct cases is explained by the previous myocardial damage — an observation in conformity with what has been said by Yater et al. (1951). Any definite shifting towards an older age group has not been observed in the recurrent cases.

The figures obtained for the frequency of recurrences in this material is equal to that provided by other statistics, but both higher and lower percentals have been reported. The same is true as regards the presence of infarctuous scars at the autopsies. If this can be taken as a starting point for determining the prognosis there is no reason to believe that the Umeå material should differ noticeably.

Among the 20 recurrent cases ending fatally and where earlier infarct was unknown, 14 came from Umeå and its surroundings, and 6 from places farther away. 11 reported previous heart complaints, 10 of these cases came from the Umeå region. Of these only two from the town of Umeå had undergone previous ECG examination. Though

the figures are small they seem further to stress the fact that the population from the countryside in particular very rarely, in spite of heart complaints, undergo such examination of the heart that would with greater certainty demonstrate a cardiac infarct.

## Chapter 5

### *Methods of Treatment*

With regard to the treatment of the acute cardiac infarct the long and tedious transport with its risk in getting the patient to the hospital has already been alluded to. It may be questioned if the benefit of hospital treatment justifies the risk taken. Many a sick person would most likely be better off quietly in bed at home. Many a heart case is cured without more rigorous treatment. This seems to be apparent from the relapsing cases mentioned already, where the primary disease has been known only at the time of an autopsy.

Very often the attack of an infarct sets in with so severe symptoms that the doctor called in or the relatives and the patient himself consider it essential to be removed to a hospital. From my own experience I must say that many of these cases stand the strain of such transport surprisingly well, and I wish to point out that even very painful cardiac conditions, so common in this type of disease, do not necessarily prevent a transport. Early diagnosis is essential, and it cannot be denied that early admission into hospital for effective treatment is desirable. A word of caution is necessary in case of transport of grave shock cases. The very high mortality in connection with this, and this has been mentioned earlier, the strain and stress of a long transport must be greatly blamed.

Regarding the treatment of admitted patients I wish to mention very briefly that the patients — according to the suggestion of Lublin (1947) — are permitted to move about and get out of bed at an early stage, which has proved beneficial particularly in the aged patient. It is also considered that the risk of thrombotic complications is thus reduced. Passive and active movement is started at the earliest possible moment in order to prevent stiffness and pain, not only in the shoulder joints which, however, are the worst and most commonly affected.

Moreover it may be mentioned that during the past few years we have included the use of heparin (Jorpes 1938) and dicumarol (Lehman 1942) in the treatment. The beneficial effect of these anti-

coagulants is supposed to act by preventing a spread of the coronary thrombosis or by preventing the formation of a parietal thrombus in close connection with the infarct with the accompanying risk of arterial embolism. They are further supposed to prevent the formation of venous thrombosis and secondary emboli, a danger these infarct patients are exposed to on account of the diminished cardiac function and the complete rest in bed. The increased tendency towards thrombus formation seen in cases of cardiac infarct to a greater degree than in case of surgical intervention, would thus be counteracted. Many authors have reported good results from such treatment. The extensive American statistical investigation inaugurated by the American Heart Association ought to be mentioned in this connection. According to a report furnished by I. S. Wright et al. (1948) it points to the result that of 432 cases treated with heparin and dicumarol there was a mortality of 15 %, while the corresponding figure for 368 cases not treated in this manner was 24 %. It shows that these anti-coagulants reduced the risk of death by reducing the thrombo-embolic complications. Such complications occurred in 25 % of the un-treated cases, and in 11 % of the treated ones and in 6 % of these latter ones in spite of sufficient amount of the drugs being given to gain satisfactory therapeutic effect. It may be added that a secondary myocardial infarct was seen in 2.5 % of such treated, and in 6.5 % un-treated cases. Based on the result of this investigation it is suggested that anti-coagulants should be given in all cases of cardiac infarct.

There is, however, criticism against the different statistics showing proof of anti-coagulants in their effect to cut down the mortality in case of acute cardiac infarct. It has been pointed out that there is considerable difficulty in obtaining a fair comparison between treated and un-treated cases, particularly as the figures of mortality vary for cardiac infarct as much as from 10—70 %. The prognosis, it has been said, is influenced by many factors such as age, sex, the condition of the patient at the time of attack and the stage of the cardiac infarct, and also by the treatment adopted. In hospital statistics care must also be taken to note if the admission has taken place in an early stage, when the mortality, as a rule, is greater than in a more advanced stage of the disease.

Among the critics against anti-coagulant treatment I wish to mention Feldman et al. (1952) who in a carefully prepared material of 189 cases of heart infarct did not find that age, sex, hypertension, previous angina pectoris or earlier infarct influenced the mortality or thrombo-embolism among the treated as compared with those not treated in this manner. Further it may be noted that Russek and Zohman (1952) among 1047 cases not treated found a mortality of 3 % in such cases as they judged as »good risks» on admission into the hospital as against 60 % among the more severely ill, and that they consider anti-coagulants being of effect against mortality in only one out of 100 mild cases and against thrombo-embolic complications in only 8 cases out of 1000 such ones. Based on this as well as on the result of a questionnaire sent out to 228 internists and cardiologists in U. S. A. — from which questionnaire could be seen that a considerable number of grave haemorrhages as complications, and also deaths, followed after this therapy with anti-coagulants — they suggest that routine treatment of this type in case of cardiac infarct is not necessary nor desirable. It ought to be given only to those classified as »poor risks». They point to the danger of the increased risk of haemorrhage, not only generally in the tissues but also in the wall of the atheromatous coronary artery and in the cardiac infarct itself. Lindén (1952), who has made a survey of a material from the Academic Hospital of Uppsala of 544 cases of cardiac infarct, warns against the complications particularly with regard to the risk of extending the haemorrhagic zonal edge as the number of cases with cardiac rupture appeared to have increased during the therapy with anti-coagulants. Lindén also found, since he had deducted those who died within the first 3 days, a mortality of 40 % among those not receiving this treatment and 30.5 % among the treated, but makes the remark that the mortality lowering effect is not definite, because the group with the mildest form of infarcts has been included in 6 % of the un-treated cases as against 18 % in the treated ones. On the other hand anti-coagulants are of value in preventing thrombo-embolic complications, the number of which was reduced from 15 % to 2.5 %. In favour of this therapy with anti-coagulants may be mentioned that H. P. Wright et al. (1953) in their experiments produced arterial



thrombosis in animals where they found recanalization after 3½ weeks if the treatment had been with dicumarol, while occlusion of the artery still persisted for several months in those cases where no such treatment had been given.

With regard to this criticism directed against the therapy of anti-coagulants in cardiac infarct I. S. Wright (1953) has, after certain remarks against the statement of Russek and after a renewed analysis of the material advocated the benefit of this therapy, including also the treatment of embolism in benign cases. He emphasizes the impossibility of deciding the danger of complications already present in the early stage. Wright admits there are risks connected with this treatment, i. e. in using heparin and dicumarol, but maintains that they are not particularly great if all precaution is taken. According to the investigation made by Wright it seems that new anti-coagulants, which have appeared, have the same influence as heparin and dicumarol and their use in the treatment does not show any advantages; some of them have definite disadvantages. It may be mentioned here that Hallem (1953), based on his own material, recommends phenyl-indanedione as effective earlier and with less risk than dicumarol.

The use of heparin and dicumarol was introduced in the therapy at Umeå Hospital in 1945 and became more generally used in 1948 when the method of combining these drugs was used. This method was described in the Swedish Press in 1944 by Suwe. A comparison shows that of 84 treated cases the mortality was  $20.2 \pm 4.4 \%$  and among 148 cases of treated  $38.5 \pm 4.0 \%$ . The difference is thus guaranteed and amounts to  $18.3 \pm 5.9 \%$ . If the 10 patients who died within the first 72 hours after the attack are deducted the mortality among the treated works out at  $19.3 \%$  and among the not treated at  $34.5 \%$ . The group of 12 cases with the mildest symptoms and without any death embraced only 3 treated and 9 un-treated cases.

Thrombo-embolic complications were present among the treated in 6 cases ( $7.1 \pm 2.8 \%$ ) and among the not treated in 8 ( $5.4 \pm 1.9 \%$ ). No case of cardiac rupture was observed among the treated, but in 4 cases among the non treated in which number one heparin case is included dying already after 48 hours after the attack. No complications of haemorrhage were seen.

It appears as if this treatment with anti-coagulants should have had a lowering effect on the mortality. A closer scrutiny of the material, however, shows that such a conclusion cannot very likely be arrived at. Consequently during the years when anti-coagulants were not given the mortality among the 79 admitted was  $30.4 \pm 5.2 \%$ . Among the 84 treated cases it was  $20.2 \pm 4.4 \%$ , but among those not treated during the same years, embracing 69 cases, the mortality was as high as  $47.8 \pm 6.0 \%$ . There seems no reason to believe that this great difference could be traced to whether anti-coagulants were given or not. Other factors must have played their part. In favour of this theory is the fact that the mortality among the treated cases shows a lesser deviation from the mortality before the »years of treatment» than among the non treated during the »years of treatment». I have already pointed to the different causes of the increased mortality during the latter years, e. g. an increased early admission and an increased admission of those seriously ill cases living close to the hospital.

The high mortality with 33 deaths among the cases not receiving the treatment during these »years of treatment» is explained by the fact of so many severely ill patients in this group. Only in 8 of them could a definite diagnosis of infarct be made with the help of an ECG intra vitam and in addition they all had signs of very grave cardiac insufficiency. In the rest of them the ECG was not typical or else the ECG was not done, the diagnosis of infarct was only obtained at the autopsy. To this group belonged those suddenly deceased after the attack of illness or those who had arrived in a very precarious condition, cases of cardiac insufficiency or cases with other symptoms predominating the picture, e. m. bleeding gastric ulcers, cerebral haemorrhage, pneumonia, endocarditis. It may also be mentioned that in this group of 33 deaths are included no less than 16 cases with evidence of infarct fibrosis as a sign of an earlier and healed cardiac infarct; a reason why the prognosis in all these cases under all conditions must have been said to be particularly bad.

The conditions during the year of 1950 are the most marked and may serve as an example. This year 46 cases were admitted with cardiac infarct. Of 39 treated cases 10 died ( $25.6 \pm 7.0 \%$ ). All the

7 not treated died. Of them 3 suffered from weakness of the heart without any typical ECG; 2 were badly run down on account of a bleeding gastric ulcer and with gastritis accompanied by softening of the brain; 2 arrived in a very precarious condition and died almost immediately after arrival at the Hospital without any ECG being done on them.

It may be added that the greater mortality among those who received no treatment also had connection with the very advanced age of the patients, prognostically badly placed, formed the majority. In the year group of 60 and above there were 84 cases not treated as against 51 treated ones.

Already from this limited material it is evident that a clear and lowering effect of the mortality has not been obtained by using anti-coagulants, and it is not possible to judge the effect by means of simple statistics on treated and not treated cases. The criticism which has arisen against the routine use of this treatment in all cases seem justified just as Rasmussen's (1952) suggestion that continued trials should be carried on in order to obtain a solid scientific foundation for this form of therapy in case of cardiac infarct.

A practical consequence of this would be that no demand can be made on severely ill patients to be brought into the hospital at any cost, when a long and strenuous transport faces the patient in order to get this particular type of treatment, in particular as this, as has been said above, does not fully prevent the risk of thrombo-embolic complications. In my material this is demonstrated by the following case:

J. No. 1003/50. Housewife, aged 50, thin, hypertonic, diabetes and with hyperthyreosis. Admitted with acute symptoms of cardiac insufficiency, duration 48 hours. ECG showed fibrillation and sign of a posterior infarct. Dicumarol was started from the beginning. During the course of this treatment with a prothrombin index of about 60 one month later there were signs of a new infarct setting in, according to the ECG an anterior one. Ended fatally 3 weeks later with symptoms of a progressive cardiac insufficiency. The autopsy showed in addition to a large and dilated heart a grave form of arteriosclerosis of the coronary vessels with marked calcium deposit, one lumen closing, a partly fixed recent thrombus in the left descending branch; posteriorly in the left ventricular wall extensive fibrosis after an old myomalacia, and anteriorly, extending on to the septum, a recent myomalacia.

After this critical survey I finally wish to stress that the indication to treat by means of anti-coagulants in cases of acute cardiac infarct still remains to prevent the formation of thrombo-embolic complications. As this treatment is not without risk it should not be adopted in a routine way in all cases. Contra-indication is present if there is a tendency to bleeding, e. g. in grave liver conditions, ulcer pepticum, ulcerative colitis, haemorrhagic disease of the blood and in case of grave kidney disease. Wherever recent cerebral haemorrhage is present this therapy is not to be recommended. Further it should not be used in »good risks» where it is not needed, and where it is more important to keep the patient moving. It ought to be reserved for serious cases and in cases of cardiac weakness, arrhythmia, collapse, valvular disease, and further at the sign of embolism or arterial- and venous thrombosis or a tendency to this, and where a protracted stay in bed is necessary. The treatment should be given under careful observation of instructions given. During the course the prothrombin index should be carefully watched as well as haemorrhagic complications; increase of the infarct with added pericarditis may all be signs to stop the treatment. Whenever at an early stage it is difficult to decide if anti-coagulants should be given or not, it seems, so far, justified to give them by taking into consideration what has been said above (I. S. Wright).

## SUMMARY

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This comparison is based on those cases of cardiac infarct admitted for treatment in the department of medicine of Umeå Central Hospital during the period 1939—1950. An increased frequency of infarct was observed here as in other places. There may be several reasons for this but it appears to be of special interest to investigate to what extent this depends on an increased morbidity of infarcts among the population.

In the first place the genesis of cardiac infarct has to be made clear. From articles in the literature it is evident that, even if other causes are present or play their part in a particular way, it is mainly arteriosclerosis of the coronary vessels of the heart which acts as the principal cause of cardiac infarct. The investigation of the problems of cardiac infarct is thus closely connected with those of the arteriosclerosis. This problem calls for greater scope so as to include also the functional elements which have a bearing on the production of an infarct. Not only are medical, chemical and pathologico-anatomical aspects connected with this problem but also social ones.

An account is given of the various theories mentioned in the literature on the pathogenesis and development of arteriosclerosis, in particular with reference to the scientific findings during the latter years concerning the importance of lipoids and their relation to foodstuffs. Many factors are involved, also in relation to the sequelae of arteriosclerosis as they appear in the statistical works on mortality in arteriosclerosis and cardiac infarct frequency. The caloric supply and the nutritional conditions and their significance are discussed.

An investigation 20 years earlier had proved that at that time there was a relatively low frequency and intensity of arteriosclerosis in the autopsy material at Umeå Hospital. It was then considered to have some connection with the food conditions of the population.



An account is given of the living conditions of the population within the receiving area of the hospital. During the two last decades there has been a definite raising of the living standard and food consumption. There is an increase in the number of old people, a decrease of the country population and migration into the built-up areas with an accompanying change in occupation.

In the medical department of the Umeå Hospital 232 cases of cardiac infarct were admitted during the period 1939—1950, 170 of these were men and 62 women. 74 died, 50 of them men and 24 women. The annual number of admissions showed, with the exception of a slight decrease 1941 and 1942, an increase which became marked in 1947, and very marked in 1949 and 1950; the number of deaths increased also, lowest in 1941 with one case, and following the increasing number of admissions, and rose particularly during the two last years. This development is in the main in accordance with the statistical reports covering the mortality in arteriosclerosis and the frequency of cardiac infarct in Sweden. The infarct frequency is definitely lower at the Umeå Hospital than is the case at certain other hospitals in the country. The figures denoting the total mortality, sex- and age distribution among the infarct patients and the number of fatal cases among them conform with the statistical reports from the other hospitals.

The number of admitted old people suffering from this disease has increased and thus raised the frequency of cardiac infarction. This is connected with the higher average age of the population which has also resulted in the increased total number of old people occupying beds. The tendency to request hospital treatment has made the total number of admissions greater — this may be one reason, but the fact remains that the number of infarct cases has been relatively greater in increase than that of the total occupancy.

Most of those admitted were from the close proximity of the hospital. They came in greater numbers than what would correspond to the distribution of the population. The highest number of fatal cases occurred among them. Those living close by arrived for admission at an earlier stage of the disease than those living farther away. The

mortality, however, seems to be somewhat higher among those who came from the neighbourhood of the hospital.

Social improvement with e. g. better means of transport has made it possible for a greater number of admissions and at an earlier stage, particularly of those living close by, and of those dangerously ill. Those living farther off have arrived in smaller numbers and in a later stage of the disease when actually their condition was in a better state. Increased knowledge of the cardiac infarct as a disease, both among doctors and the man in the street, has contributed to the increased frequency of admission. This has also resulted in admission of the cases at an earlier stage of the disease, particularly those worse off, and this has naturally been from the close neighbourhood of the hospital. Thus increased knowledge and improved social conditions seem to give the most likely answer to the increased frequency of infarcts at this hospital and especially to the rising number during the past few years.

The rising mortality among those admitted during the past few years has a bearing on the increased number of admissions at an early stage of the disease and also on the number of seriously ill cases seeking hospital treatment. From the social conditions and the time interval after the first attack when the patients arrived at the hospital a deduction can be made that the otherwise marked early-mortality is not noticeable here; further the number of grave shock-cases was relatively small but the mortality among these cases was very high. Any reason to believe that extraordinary conditions should prevail here regarding cardiac infarct as a disease do not appear to exist.

As mentioned above the medical department of the Umeå Hospital has a relatively low frequency of admission of cardiac infarcts. In order to appreciate the conditions of morbidity among the population it is noticeable that with respect to the distribution of population there is a proportionately greater number of admissions of infarct cases from towns and municipalities than from the surrounding county districts. From the Umeå region, which embraces the greatest number of inhabitants from built-up areas with 37.3 % of the population, came 68.4 % of the admissions. The admissions from this regional countryside were in proportion to the number of inhabitants greater

than from the rest of the countryside. The distance to the hospital and the means of transport have probably resulted in this difference in the figure of admission, but it does not provide the full explanation.

In addition to the cases in the dept. of medicine during 1939—1950 there were 9 cases admitted into other departments on which autopsy was performed. A questionnaire sent out to the district medical officers revealed only a small number of 48 cases which have not been included in the hospital report, most of them apparently very ill patients who could not stand to be moved, and the majority died. Most likely the number of cardiac infarct cases would be further increased within the receiving area in order to obtain a true frequency of morbidity. The percentages of the mortality in cardiac infarct among the citizens of cities like Gothenburg and Umeå are fairly similar. Figures of comparison published in the hospital statistics covering more southern parts of Sweden indicate however a considerably higher frequency. The author has reason to think that the morbidity in cardiac infarct within the receiving area of Umeå Hospital is relatively low and this is particularly true among the population out in the countryside. A survey according to sex- and occupational distribution as well as the place of residence of the patients indicates a lower infarct morbidity among men and women from the countryside as compared with those from the towns and municipalities, lowest among the farming population and highest among the males in towns and municipalities.

With regard to the importance of arteriosclerosis and its connection with cardiac infarct, and the common relation of arteriosclerosis to obesity and hypertonia, a review has been made of the influence and discussed in connection with this material. Comparing the cases it appears that obesity increases the risk of infarct formation, but does not enhance the mortality. The greatest frequency of falling ill was for obese men in the 6th decade, for obese women in the 7th which tallies with the development of arteriosclerosis according to age both in men and women. The lowest average age was noted among the obese men. In proportion to the size of the population the lowest number of admissions was found among lean people from the countryside, while the highest was represented by obese people from towns

and municipalities. A comparison shows that hypertension also predisposes to cardiac infarct, but more uncertain if it influences the mortality from this disease. In proportion to the distribution of the population there was a greater number of admissions of hypertensive cases from towns and municipalities than from the countryside, obese hypertensive cases included. The lowest frequency of admission of hypertensive cases is seen among the lean patients from the country. The author is inclined to consider the lower infarct morbidity among the country folk to be in connection with less frequent arteriosclerosis and a more common lean constitution than in those from towns and municipalities. The active and physical work and less mental strain of the farming population seem to be contributory factors. Certain investigations suggest that a general increase in body weight has taken place among the population. This may have been a contributory cause of the increased infarct frequency. It is also believed that the transfer taking place from farm work to life and occupation in the towns will increase the risk for infarctuous disease.

Estimation of the cholesterol content of the blood did not suggest that an increase here would be the rule in this material. Arcus senilis corneae was not more commonly present in those with higher blood cholesterol than in others.

Functional elements which put an extra demand on the nutrition of the heart muscle may, as a rule, be considered as releasing causes in producing an infarct when this demand cannot be satisfactorily met. The most common cause of such provocation becoming serious is to be found in coronary sclerosis, but even extra-coronary causes are present. For different reasons previous heart complaints are not always paid attention to, and the releasing factor appears very often to be of a mild form when the heart is ready, so to speak, for the production of an infarct. In this material earlier heart complaints were reported in 65.1 % and angina pectoris in 42.2 % of the cases. A releasing cause was found in 33.2 %. In 20.3 % of the cases the symptoms of cardiac infarct appeared without any previous heart complaints or without any releasing cause. In 23.7 % the symptoms cropped up while resting and in 17.2 % during sleep. Cold weather does not seem to be of provocative importance. Releasing causes were



noted more frequently in those from towns and municipalities than in those from the countryside.

Of the 74 fatal cases 69 were submitted for autopsy. 46 of them were men (66.7 %), and 23 women (33.3 %). 75.4 % were 60 years old or older. Among them were 32 men and 20 women. In the age group below 60 there were 14 men 3 women. 83.3 % came from towns and municipalities. Obesity was present in 37.5 %, normal nutritional condition in 42.0 % and leanness in 20.3 %. Hypertonia present in at least 50.7 %, diabetes in 6 cases.

Coronary sclerosis was present in all autopsy cases; very marked in 75.4 %, average in 18 % and mild in 5.8 %. Very marked coronary sclerosis was seen in all the age groups, but most common among the older patients; it was present in the younger men more often than in younger women, more common among those from towns and municipalities, and oftener in those with obesity as compared with those of normal weight, oftener in those who had hypertension than in those with normal blood pressure, and finally, in most of them who suffered from diabetes. The majority of the lean ones were of old age and had hypertension in diseases often accompanied by leanness. From this it is evident that these conditions which, according to what has been said already, predispose to cardiac infarct also seem to favour the production of marked arteriosclerosis.

Even if the majority of cardiac infarcts occur in connection with marked coronary sclerosis, the origin of cardiac infarct is not clearly explained. An acute interference with the nutrition of the myocardium is the main foundation for the production of an infarct. It is evident that the severity of the coronary sclerosis is not the determining factor. In addition to this it must be mentioned that the cases with occlusion and those without occlusion were about equally common. Occlusion was observed in 35, of which number 30 with thrombosis, stricture in 4 (one of them with thrombosis) and embolus in one case. In 34 cases no occlusion was observed. Very marked coronary sclerosis in the occlusion cases was seen in 85.7 %, and in the no-occlusion cases in 64.7 %. In cases of mild coronary sclerosis no case of occlusion was found. Marked coronary sclerosis would thus favour the production of occlusion. The most common cause of occlusion



is thrombosis. It is, however, doubtful if the thrombosis, the production of which seems to be favoured by local changes in the vessels, is a primary cause of an infarct. It is further evident that in the occlusion cases the alterations in the coronary vessels were the most striking, in the no-occlusion cases cardiac hypertrophy was most predominant.

Cardiac hypertrophy was present in 66 cases (95.7 %) of the 69 submitted for autopsy. It occurred with very marked coronary sclerosis in 75.8 %, with hypertonia in at least 50 %, occurred in the obese in 36.4 %, and in those with normal weight in 43.9 %, and in the lean ones only in 19.7 %. This points to the fact that functional elements have a considerable influence in producing an infarct.

The result of the functionally poor and deficient blood supply is clearly seen in the 13 cases with average coronary sclerosis and the 4 cases with the mild form. In 6 of the cases with average sclerosis certain local vascular changes were present, which would have interfered with the blood flow, and in 5 of these thrombosis was observed. But in all the 17 cases except one — with an atheromatous change in the vessel producing a stricture, adipositas and previous severe mental strain, — cardiac enlargement was present, very marked hypertrophy in 13 cases, and in addition cardiac disease or disease of another nature, which would have adversely affected the function of the heart and its blood supply.

From the notes on releasing causes present it is further seen that these, as observed in 21 cases, were equally often seen in occlusion cases as in no-occlusion cases, and that very marked coronary sclerosis was not a decisive factor in the production of an infarct in them. Nor was it decisive as to whether previous heart complaints had been present or not. Such complaints occurred in 65.5 %, angina pectoris in 46 %. Very marked coronary sclerosis with concurrent cardiac complaints were noted in 73.1 %, angina pectoris in 53.8 %.

Where no acute occlusion is the cause, the production of an infarct seems to be influenced by functional elements. Though very marked coronary sclerosis was present in most cases, the severity of the sclerosis did not appear to be decisive for the production of

an infarct. In cases of a mild form of coronary sclerosis it was extra-coronary cardiac disease or disease of another nature which produced a faulty function of the heart and its blood supply. The conditions which have been listed as predisposing to cardiac infarct, observed in the patients on admission, have been verified in the autopsy material.

Electrocardiographic examination has been carried out on 51 of the 69 cases. 29 had definite signs and 13 very likely signs of cardiac infarct. In the other 9 cases there were clinical symptoms of an infarct but definite electrocardiographic signs were not present. At the autopsy infarcts of the anterior wall were found in 38 cases (42.2 %), of the posterior wall in 33 (36.7 %) and in the septum of 19 cases (21.1 %).

In the total material there were 36 (15.5 %) recurrent cases. 28 (77.8 %) of these died. 16 of these were previously known by means of ECG, the other 20 were discovered at the autopsy.

Taking the treatment into consideration a warning is justified as regards the transport of severely ill patients. A clear and positive evaluation of the therapy with anti-coagulants does not appear in this work. Among 84 cases thus treated the mortality was 20.2 %, while among 148 not treated with anti-coagulants the mortality was 38.5 %. But the frequency of thrombo-embolic complications was in the former group 7.1 % with 5.4 % in the latter. A closer survey of the material also shows that a simple comparison is not sufficient for the solution of this problem. Different factors, where anticoagulants did not play a part, have contributed to the varying figures of mortality. Particularly noticeable is the fact that those not so treated have been very seriously ill patients. In spite of being under treatment with dicumarol a patient developed coronary thrombosis and a relapse of his infarct. As the treatment with anti-coagulants is connected with certain risks it should not be given in a routine manner.

## CONCLUDING REMARKS

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1. The increasing frequency of admitted cases of cardiac infarcts, during the period 1939—1950, in the department of medicine of the Umeå Central Hospital depends very largely on a better knowledge of this disease and of the social conditions resulting in patients especially from the neighbourhood of the hospital seeking admission in greater numbers and at an earlier stage of the illness. On the other hand the increased number of admissions seem to point to an increased morbidity among the population; in the first place on account of the greater number of old people but also to the fact that an improvement in the living standard and food conditions may have contributed to this state of affairs.

2. The frequency of admission is lower at Umeå Hospital than what has been reported from certain other places. This seems to have a connection with a low frequency of morbidity among the population, and particularly the population of the countryside. The cause for this is to be found in the low number of arteriosclerosis cases. As contributory causes may be mentioned a more prevalent leanness and a smaller number of hypertensive cases among the country folk, and in addition there is less mental strain and stress and their occupation is more of the physical type. An investigation carried out on a number of the patients showed that the cholesterol content of the blood was not raised as a rule.

3. The origin of cardiac infarct is in the majority of cases associated with arteriosclerosis. The conditions required for the production and development of coronary sclerosis also play their part in the production of cardiac infarct. The severity of the coronary sclerosis is, however, not the decisive factor. That functional elements contribute is shown in the cases where there has been a milder form of

coronary sclerosis but, in addition, a cardiac hypertrophy has been present. Occlusion, mostly with thrombosis, has been common with cases of very marked coronary sclerosis. Vascular changes have been essentially instrumental in producing the thrombosis. The importance of the thrombosis as the primary cause of an infarct seems on the other hand uncertain.

4. The treatment of an acute cardiac infarct with anti-coagulants ought not to be given in a routine manner. This treatment is indicated where there is risk for an ensuing thrombo-embolic complication.

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